A MANUAL OF RADIOLOGICAL DIAGNOSIS

FOR STUDENTS AND
GENERAL PRACTITIONERS

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W. HEFFER & SONS, LIMITED
CAMBRIDGE

Dedicated to
MY MOTHER AND FATHER

First Published 1937

Printed in Great Britain by
L. T. A. ROBINSON LIMITED, LONDON, S.W.9

FOREWORD

Dr Tchaperoff is to be congratulated on having produced a work original concise and filling a very patent gap in the field of X ray diagnosis There is as far as I am aware no similar publication and every medical practitioner will find extremely useful the brief but comprehensive descriptions of both the anatomy and X ray appearances of injuries and diseases throughout the whole human system while the production of X rays themselves is so excellent that they may safely serve as a standard with which to compare any X ray photograph of which the diagnosis is doubtful

In the preface Dr Tchaperoff draws his readers attention to the fact that because the X ray offers an easy method of diagnosis a thorough clinical examination must on no account be neglected As a clinician and teacher of surgery I would again emphasise the fact that X ray examination must be regarded only as a method of confirming and amplifying the clinical diagnosis though as such it is of very great value

PHILIP H MITCHINER

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INTRODUCTION

This book presents a synopsis of the essentials of Radiological Diagnosis

The improved qualities of X-ray pictures and the ever-increasing facilities for obtaining them have made radiology part of the regular routine of clinical diagnosis So much so, in fact, that a course in radiology forms part of the student's curriculum for every qualifying examination For the higher examinations a sound working knowledge of radiological diagnosis is essential The General Practitioner too, is expected to understand the reasoning on which the expert radiologist bases his report, and to co-ordinate it with his clinical findings

Even when the X-ray picture shows a negative result a stimulus, is often given to renewed and extended physical examination as is exemplified in a case that recently came under our notice A patient was suffering from haemoptysis. A skiagram of the chest failed to reveal any abnormality Further clinical examination was thus called for and a haemangioma was at length discovered in the naso-pharynx, the slow haemorrhage from which, reaching the larynx by gravity, was coughed up and thus simulated a genuine hæmoptysis

The METHOD of assessing the value of the information afforded by a skiagram is all-important The picture must be carefully analysed step by step The findings of the expert are as often based on minute points as on gross appearances The details are liable to be overlooked unless a systematic study of the picture is undertaken It is this systematic method which the following pages seek to inculcate, and to illustrate by numerous examples, first from a general and then from a regional point of view Some of the rarer conditions are also included for the assistance of those offering themselves for the higher examinations

For purposes of differential diagnosis the following way of using this book is suggested First read the general chapters relating to the system under investigation, carefully noting the characteristic responses of that system to the various diseases to which it is prone Then read the corresponding part of the regional account comparing the pathological changes with the normal appearances In this way a reasoned 'reading' of the X ray picture will be made and a fallacious guess that a given picture 'looks like' a certain disease will be avoided

ACKNOWLEDGMENTS

The Author wishes to express his gratitude to Dr Geoffrey Fildes, Director of the Radiological Department of St Thomas's Hospital, London, for his kind permission to use the radiographs made in that department, for his encouragement, and for the facilities afforded by him,

also to Dr Bertram Shires, Honorary Radiologist to St Thomas's, for several suggestions and criticisms,

to Dr G T Hebert, Director of the Tuberculosis Department of St Thomas's, for the use of typical chest radiographs,

and to his own associates in the hospital, especially Dr J W McLaren

He also thanks Mr Charles Porter, M A, for his help and enthusiasm and Messrs L T. A Robinson Ltd, for the care and pains they have taken with the printing and reproductions Finally he wishes to record his deep indebtedness to Mr Philip Mitchiner whose wide experience of teaching surgery makes his foreword so valuable

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CHAPTER I

X-RAY PHYSICS AND TECHNICAL CONSIDERATIONS

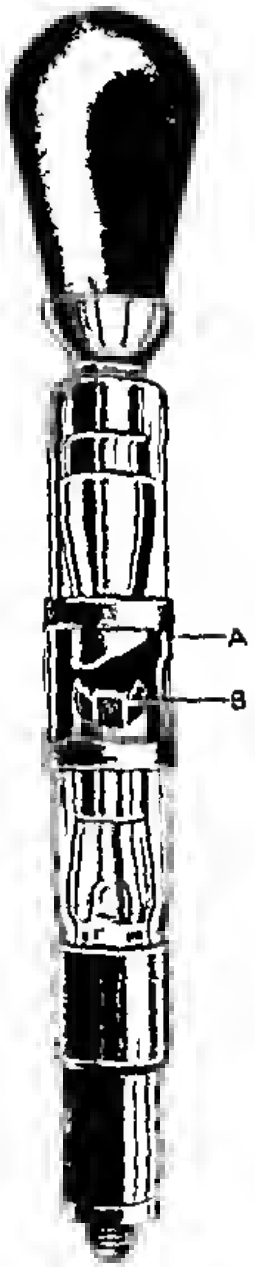


PLATE I

Philips X ray Tube (hot cathode type) (A) Target. (B) Cathode filament

The difference between X-rays and light. The physicist has proved that all radiation throughout the spectrum finds its origin in what may be termed the unrest of electrical charges Both light and X rays are propagated in straight lines, are reflected diffracted refracted and polarised, but to a different degree depending on their wavelength It is this difference in wavelength which makes objects opaque to light but not to X rays

The production of X-rays. X-rays are generated in an X-ray tube when the anode or target is bombarded by a rapidly moving stream of electrons from the cathode

The X-ray tube. The original type of X ray tube used is known as the gas tube In it a small quantity of residual gas in a vacuum space is split up into electrons which form the cathode stream when a high tension voltage is applied between the terminals of the tube

The hot cathode or Coolidge tube has replaced the gas tube The cathode is heated to incandescence by an independently controlled current and emits electrons which, impelled by the high tension voltage, strike the target and generate X rays (Plate I)

THE EFFECT OF X-RAYS

(1) *Fluorescent action*
(2) *Photographic action*,
(3) *Biological action*

(1) Fluorescent action. The fluorescent effect is produced when a beam of X rays falls on certain salts, which by excitation emit light radiations visible to the naked eye

Two screens are used in conjunction in fluoroscopy *a fluorescent screen*, usually consisting of barium platinocyanide in powder form, carried in a suitable vehicle on a sheet of cardboard, and *a screen of lead glass*, placed between the observer and the fluorescent

screen, which stops the X ray beam while permitting the fluorescence to be seen

(2) Photographic action. The effect of X rays on a photographic plate is similar to that of light, except that the plate is more sensitive to a smaller change in the density of the X ray beam than it is to that of light

The fluorescent action of calcium tungstate (blue) is also utilised to intensify the action of the X-ray beam on the photographic film This is accomplished by mounting the film between a pair of screens coated with calcium tungstate or other similar substance Under X-rays the fluorescence from the tungstate acting on the photographic plate reduces the necessary exposure to one-quarter or one eighth of the exposure without screens

(3) Biological action. X rays are capable of producing destructive changes in living cells, but not with the short exposures to which a patient is ordinarily submitted for radioscopy or radiography

THE USE OF X-RAYS IN DIAGNOSIS

The use of X-rays in diagnosis depends on the fact that these rays are capable of penetrating light opaque objects to a greater or lesser degree, which may be recorded on a photographic plate or viewed on a fluorescent screen as shadows of varying intensity

The degree to which the X ray beam penetrates an object depends directly on the penetrating power of the beam and the density of the object

There are certain factors which the radiologist must regulate so that the difference in density and the true shape of the object under examination are correctly rendered For this he must have a clear understanding of what the radiograph is intended to show in order that the factors may be balanced Thus, with the patient in the same position, by altering the factor of exposure it is possible to produce a picture of the thoracic spine without evidence of the mediastinum or lungs, or a picture of the heart and lungs without the thoracic spine

RADIOGRAPHIC DISTORTION

While it is the aim of the radiologist to diminish distortion as much as possible, to make the reading of the X ray film easy, there is, of necessity, some distortion existing in every picture, since X-rays come from a relative point source The true relations of objects lying between the film and tube can only be recorded in their true shape when the distance between the tube and object is of such magnitude that the rays from the X ray beam striking the object are relatively parallel

Most radiographs of the limbs can be taken at a distance of 30 inches between the plate and X-ray tube without distortion being apparent, but in pictures of heart and lungs it is necessary to increase the distance to 6 feet to prevent distortion in the relative size of the heart and thoracic cavity Where this is of importance, as in heart shadow measurements, special methods of projection are used (orthodiagram)

The single X ray picture shows everything in two dimensions Unless the observer can re interpret the picture in three dimensions, another picture at right-angles to the plane of the first must be taken to orientate the original picture Thus the meaning of various lines and shadows can be interpreted in their true planes The same effect can be obtained by stereoscopy

Where doubt exists as to whether the density and outline of the shadows in an X ray picture of an arm or leg are normal, the question is easily settled by taking films

of the opposite member, or by additional radiographs of the limb taken from some other aspect

STEREOSCOPY

On the photographic plate it is impossible to tell the spacial relations of the different objects seen Where this is of importance, as in regions which can be X rayed only in one plane, or where the relation of a foreign body to the surrounding bones must be determined, stereoscopy must be applied This consists of taking two pictures of the part to be examined in the same plane on separate films the X ray tube being shifted (usually 6 cm) parallel to the plate between the two exposures, while the relation of patient and film remains the same

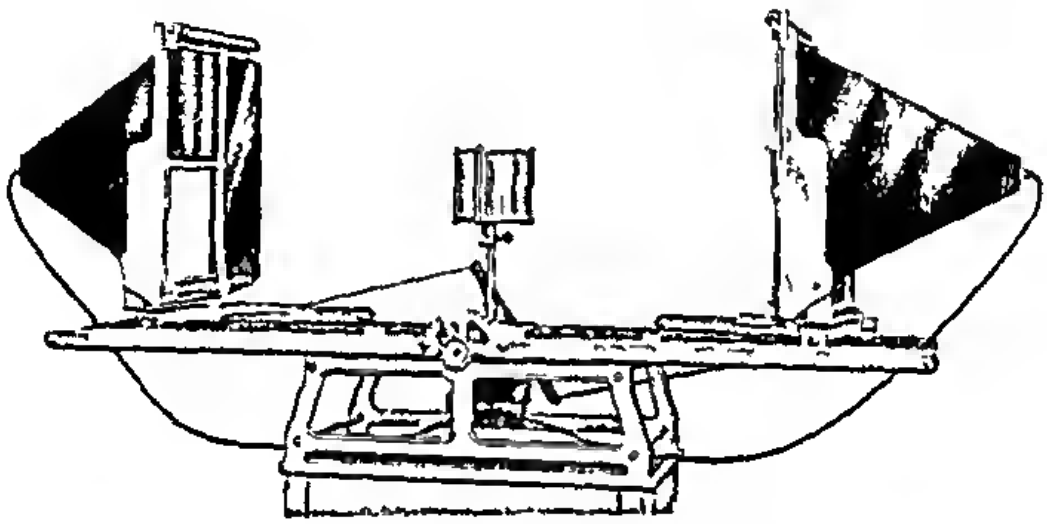


PLATE 2
Stereoscope

The stereoscopic effect is obtained by placing the pair of films in a stereoscope for viewing This consists in its simplest form of a pair of mirrors mounted in such a way that, by adjusting the angle between the two mirrors and looking into them, the pictures of the two films are made to coincide stereoscopically The spacial relation between the different parts will then be seen

Plate 2 shows a typical stereoscope for the examination of X-ray films The pair of films are placed in the two viewing boxes and the observer examines them by looking into the mirrors

Stereoscopy is of special importance for the following areas —

(1) *Skull,*
(2) *Shoulder,*
(3) *Hip,*
(4) *Spine*

DEVICES USED TO ELIMINATE SCATTERING OF X-RAYS

When a wide beam of X rays passes through thick parts of the body it undergoes scattering, which tends to fog the picture This may be lessened by using —

(*a*) a restricted cone of X rays produced by the use of a small cone diaphragm attached to the X ray tube
(*b*) a Potter Bucky grid,
(*c*) a combination of both methods

The Potter Bucky grid consists of alternate lead and wood slats which are made to travel across the plate during the exposure, thus allowing only direct rays from the tube to reach the film and cutting off secondaries which tend to fog it

Plate 3 shows the action of a typical Potter Bucky grid and its action in eliminating unwanted rays

Plates 4, 5 and 6 show radiographs of a hip-joint with unrestricted rays with cone, and with cone and Potter-Bucky grid. It will be seen that the use of

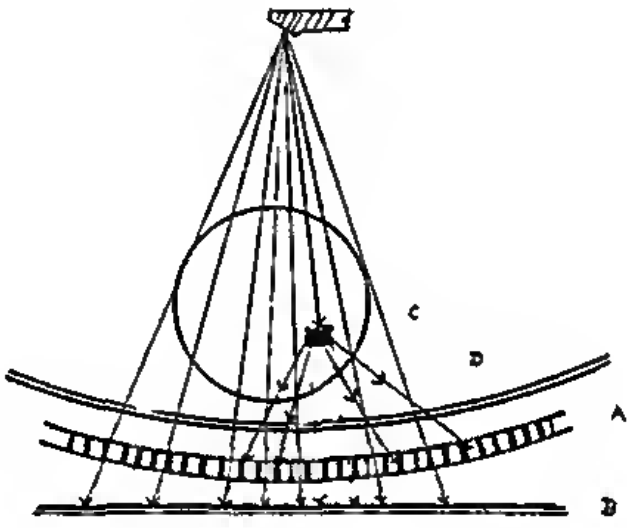


PLATE 3

A—moving grid
B—X ray film
Only the direct rays from the X ray tube reach the film. Secondary rays D scattered by C do not reach the film

a restricted cone and Potter Bucky grid combined, by preventing scattering of the rays produces a picture showing the maximum contrast and detail

NEGATIVE AND POSITIVE

The radiographs taken on exposing a film to X rays is known as a **negative**. On taking a contact print from this a **positive** image is obtained.

In a negative the *radio opaque* objects appear on the film as *translucent*, whereas in a positive the *radio opaque* areas are opaque (blackened).

In many cases it is impossible to produce positives which give the same shadow values as those seen on examining the negative by transmitted light. The positive is difficult to read since as the original is a negative, it is necessary to re interpret mentally blacks into whites.

In this book all radiographs are shown as negatives so that no re-interpretation is necessary when comparing the pictures with actual X ray negatives.

Plates 6 and 7 show a negative and positive reproduction of a hip-joint.

PLATE 4

PLATE 5

Plates 4 5 6 show how the bone detail, in bone situated in the thick parts of the body is improved by using a restricted cone of X rays and the effect of also using a Potter Bucky grid 4—Unrestricted ray 5—Ray restricted by use of a cone 6—Ray restricted by use of a cone and secondaries further eliminated by Potter Bucky grid

PLATE 6

PLATE 7

ABBREVIATIONS

A - P —Antero posterior view
The X ray beam passes from anterior to posterior aspect The X ray film is on the posterior aspect

P A —Postero anterior view
The X ray beam passes from anterior to posterior aspect The X ray film is on the anterior aspect

Lat —Lateral view

BONES AND JOINTS (GENERAL)

CHAPTER II

BONES AND JOINTS (GENERAL)

THE RADIOGRAPHIC APPLARANCE OF NORMAL BONES AND JOINTS

The appearance of the normal bone and joint radiograph must be known before pathological changes can be diagnosed The film may show variations from the normal in —

(1) The outline of the bone and its internal structure
(2) The surface of the bone taking part in the formation of the joint
(3) The space between the bones forming the joint
(4) The outline of the soft tissues

(1) **The outline of the bone and its internal structure** is subdivided radiographically into the following parts (Plate 8) —

(*a*) The cortical layer the subperiosteal compact layer which is highly opaque normally homogeneous and structureless The periosteum cannot be recognised from the soft tissue shadow
(*b*) The cancellous bone which shows trabecular structure and calcification to a varying degree
(*c*) The medullary canal

(2) **The surfaces of the bone taking part in the joint formation are covered with** cartilage which is non-opaque to X rays but cartilage which is diseased may undergo calcification and become opaque to a varying degree

(3) **The space between the bones forming the joint** can only be diagnosed as increased or diminished when the change is gross or if the change is small by comparison with that of the other limb

(4) **The outline of the soft tissues** is usually seen and swellings of the tissues are often shown as alterations to the normal contour of the limb

DISEASES OF BONE (GENERAL)

Pathological changes in bone structure Pathological changes in the bones show themselves as abnormal variations in the density of the radiographs

(1) **Rarefaction of bone is of two types**
(*a*) *Osteolysis* or *Osteoporosis*—by which is meant decalcification—may be general or localised It is seen as an area of increased translucency
(*b*) *Osteoclasis* is destruction of the bone by erosion as opposed to decalcification

(2) **Increased bone formation (Osteoplasia)** is of two types
(*a*) *Osteosclerosis*—hypercalcification—which may be general or local It is seen as an area of decreased translucency most marked in the cancellous bone areas

(*b*) The term *new bone formation* should be restricted to describing modification in the bone contour brought about by the laying down of *new* bone

Rarefaction of bone and increased bone formation may be localised to a small area and may affect the whole bone or the whole skeleton It is from these variations in the X ray appearances that diseases of the bone are recognised

In **Osteopoikilia**, as described by **Albers Schonberg** the bones show small opaque dense islands in the cancellous bone varying in size from a millet seed to a bean The change may be seen in any bone except the skull and ribs Osteopoikilia appears to be hereditary but is of no definite pathological significance (Plate 9)

PLATE 8
(1) Cortical layer (2) Cancellous bone
(3) Medullary canal

PLATE 9
Osteopoikilia
Note the opaque dense islands of bone

CAUSES OF THICKENING OF THE CORTEX
(Periostitis ossificans)

(1) *Traumatic*
- (*a*) associated with fracture The external callus when formed bridges the fracture
- (*b*) not associated with fracture In this there is a localised area between the periosteum and cortex into which a haemorrhage has taken place forming a subperiosteal haematoma which has become calcified This change is restricted almost exclusively to the long bones (see page 32)

(2) *Osteomyelitis* (*chronic*)
- (*a*) the cortical change is extensive and associated also with changes of the cancellous bone (see page 34)

(*b*) a small area of thickening of the cortex may be seen associated with chronic infection of the soft tissues as in chronic ulcer of the leg

(3) *Syphilis* a multiple long bone lesion which affects often the whole shaft of the bone (see page 39)

(4) *Sarcoma* in the early stage a small area of very irregular spiculated bone of radiating type may be produced (see page 60)

(5) *Scurvy* A multiple bone lesion is produced by calcification in haemorrhages around the diaphyseal ends of the bone (see page 46)

(6) *Paget's disease* The cortical change is very extensive and associated with changes of cancellous bone usually a multiple bone lesion (see page 42)

PLATE 10
Recent Supracondylar Fracture

PLATE 11
Old Ununited Fracture Excessive callus formation th fractured edges are rounded off

(7) *Melorheostosis* The change consists in a dense cortical hyperostosis of sclerosing bone type very rare (see page 44)

TYPES OF BONE CYST

The most important types are —

(1) **Primary bone cysts**
(2) **Cysts of generalised bone disease**
  (*a*) Paget's disease
  (*b*) Fibrocystic disease
  (*c*) Osteoarthritis
(3) **Cysts associated with bone tumours**
(4) **Parasitic cysts—hydatid**

(5) **Cysts of jaw**
- (*a*) Dentigerous cysts
- (*b*) Dental cysts

FRACTURES (GENERAL)

Radiographic appearance of fractures The radiographic evidence of a fracture depends on the recognition of a solution of continuity of the bone with alteration in the normal axis and outline of the bone at the point of fracture

Radiographs of the bone should be taken in its long axis in two planes at right angles to each other the antero posterior and lateral being most frequently chosen in order that the existence of any degree of displacement may be noted In fractures

PLATE 2
Greenstick Fracture

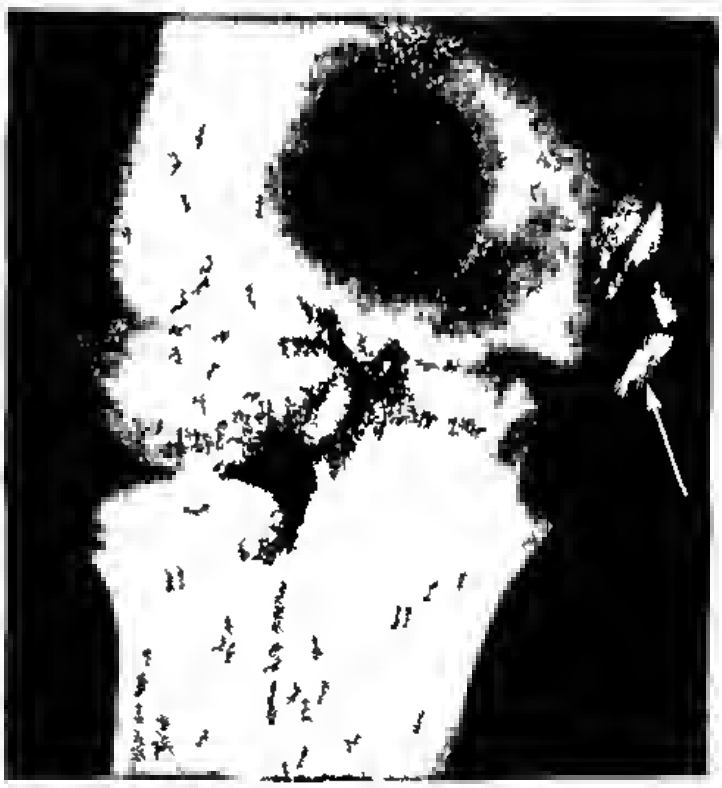


PLATE 3
Fracture Separation of Internal Epicondyle

of the neck of the femur and humerus it is usually impossible to obtain a lateral view without distortion and in these cases stereoscopic radiographs must be obtained

(1) **The recent fracture shows** (Plate 10)
- (*a*) sharp outline of the fracture edge
- (*b*) the absence of expansion of the bone except from the splitting of the shaft if present
- (*c*) no cortical or cancellous bone reaction
- (*d*) no callus formation
- (*e*) impaction of fragments

(2) **Old ununited fracture shows** (Plate 11)
- (*a*) rounding off of the sharp edges at the fracture line

(*b*) expansion of the shaft close to the fracture,
(*c*) osteosclerosis of the bone around the fracture,
(*d*) callus formation—profuse or scanty—with failure to bridge the gap

(3) Greenstick fractures in children (Plate 12)

In the bones of children where a greenstick fracture occurs, the fracture line may *not* be traceable from one side of the bone to the other, but there is evidence of alteration of the normal outline and axis

DEGREE OF SEPARATION BETWEEN FRAGMENTS

This can be seen by examining films taken in two planes Rotation of the shaft can only be detected by noticing whether the bony landmarks are in their correct relation to each other above and below the fracture It is of special importance in fractures of the lower ends of the humerus and the upper end of the femur

CALLUS FORMATION

Callus formation may be seen as early as the second week after fracture The time of its appearance varies with the position of the fracture, the age of the patient and his general health Callus formation may be delayed as much as a year in exceptional cases The X ray appearance is that of a structureless opacity less dense than the cortex, surrounding the end of the bone and bridging the fracture It can be recognised as —

(1) External callus a spindle shaped expansion around the cortex bridging the fracture

(2) Permanent callus between the opposed fracture ends of the cortex

(3) Internal callus between the medullary portions of the bone

In a variable time from three to six months in the arms and one or two years in the legs, when union has taken place the callus is absorbed and replaced by normal bone structure, so that the presence of a united fracture after some years may be impossible to detect if alignment of the fragments has been good

BONE ATROPHY ASSOCIATED WITH FRACTURE

Disuse atrophy following fracture occurs frequently in the aged where massage and adequate movements have been neglected It is seen most often in the bones of the hand and wrist following a Colles' fracture

Acute bone atrophy of the distal fragment of the fractured bone alone is a rare condition When it occurs it is seen most frequently in fractures between the junction of the lower and middle thirds of the radius The fracture line appears to pass through the zone of the canal of the nutrient vessel The mechanism causing the atrophy is obscure

DELAYED EVIDENCE OF FRACTURE

(*a*) Sometimes callus formation without evidence of a fissure or deformity in the bone may be seen in the second week after injury This applies especially to —

(i) Marching fractures,
(ii) Some pelvic fractures
(iii) Fractures of the clavicle in children

(*b*) Deformity of bone from weight-bearing without direct evidence of fracture, can be detected by alteration in the normal shape of the bone This is typically seen in

Kummel's disease of the spine, which is post-traumatic Sometimes it appears years after injury (see *Kummel's disease*, page 106)

The fact that a fracture can, soon after injury, be apparently missed when radiographed, is sometimes of medico-legal importance, since a subsequent picture may show both callus and deformity

TRAUMATIC SEPARATION OF EPIPHYSIS (Plate 13)

A **Immediate evidence of injury to the epiphysis** consists of —

(*a*) widening of epiphyseal line with fracture line running into the bone,

(*b*) alteration of the normal position of the epiphysis on the diaphysis without change in the normal density of the epiphysis

PLATE 14
Haematoma Undergoing Calcification

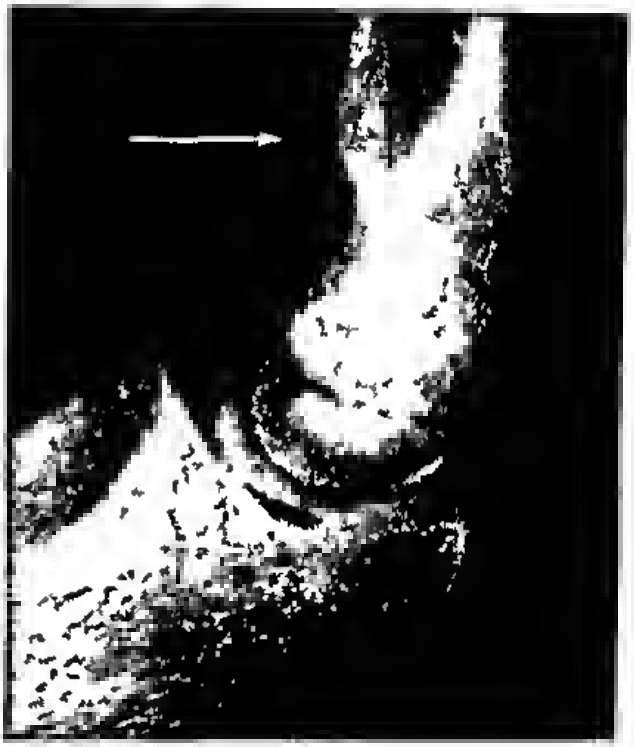


PLATE 15
Myositis Ossificans
Area of calcification in muscle indicated by arrow

The most common injury of this type is fracture-separation of an epiphysis when a small fragment of the diaphysis is carried away with the epiphysis

B **Delayed evidence of injury to epiphysis.** It shows itself by premature union of the epiphysis following injury without displacement but with failure to continue normal growth In the case of injury to the lower ends of the radius it may result in Madelung's deformity (see page 143)

SUBPERIOSTEAL HAEMORRHAGE (Plate 14)

In some cases when injury has resulted in haemorrhage under the periosteum, this subsequently becomes calcified and is thus visible to X-rays at the end of the second week Its radio-opacity is similar to that of callus and does not usually persist beyond three months

MYOSITIS OSSIFICANS (Plate 15)

This is a post traumatic condition in which the periosteum is detached from the bone A shadow, with the density of the cortex stretches from the bone into the muscle It occurs most often in the tendon of brachialis anticus muscle in fractures around the elbow-joint but can occur also in other situations

PATHOLOGICAL FRACTURES

The bone structure above and below the fracture line is altered either by localised osteosclerosis or bone destruction depending on the pathological process present The commonest causes are —

(*a*) Cyst,
(*b*) Gumma
(*c*) Paget s disease
(*d*) Carcinomatous deposit in bone
(*e*) Sarcoma of bone

DIFFERENTIAL DIAGNOSIS OF FRACTURES

Fracture must be differentiated from —

(1) **Artefacts,** which may be produced by defects of the films, strapping outline and splint contours

(2) **Normal bone markings—**
Vessel channels in bone they have a softer edge than the fracture line, e g arterial grooves in skull, humerus and metacarpal bones

(3) **Epiphyseal lines** Care must be taken to visualise the epiphyseal line all round the bone, otherwise part may be mistaken for a fracture This constitutes a common error in diagnosing a fracture at the upper end of the humerus

(4) **One bone overlapping another** This sometimes gives rise to difficulty, especially in lateral views of the ankle-joint but by tracing the bone outline down the shaft, the supposed fracture line will be seen to merge into it

(5) **Sharp angulation of the bone in relation to the plane of the X-ray film may** produce the appearance of abnormal alignment simulating a fracture This is seen in some radiographs of the clavicle in children

(6) **Osteochondritis of bone** (*see page 51*) The *irregular fragmentation* of bones without typical fracture lines is only likely to cause confusion in osteochondritis of the tarsal and carpal bones but in these conditions the bones show areas of sclerosis

OSTEOMYELITIS

Forms (1) Acute, (2) Subacute, (3) Chronic

(1) **Acute osteomyelitis** produces no recognisable X ray change in the bone within the first three to seven days of the disease The value of an X ray examination at this stage is that it eliminates other diseases which, while being confused with it clinically produce often recognisable X ray changes

Differential diagnosis —
(i) Fracture in childhood produces a specific X ray picture
(ii) Congenital syphilitic epiphysitis produces a specific X-ray picture (page 42)
(iii) Infantile scurvy produces a specific X-ray picture (page 46)

(2) In Subacute osteomyelitis (Plate 16) at about the fourteenth day a small area of cortex appears thickened with an area of rarefaction in the cancellous bone deep to it, ringing a small sequestrum which may be separated The whole bone shows the glassy type of bone atrophy

(3) Chronic osteomyelitis (Plates 17 and 18)

Site affected Any bone or bones can be affected but a single bone is most often involved Metastatic infection usually produces changes in the shafts of the long bones Infection of the ends of the bones occurs rarely except in the epiphysis in children

Any part of the bone may be affected from direct spread of the infection from adjoining soft tissues, as in abscess of the thigh or infection of the distal phalanges following a whitlow

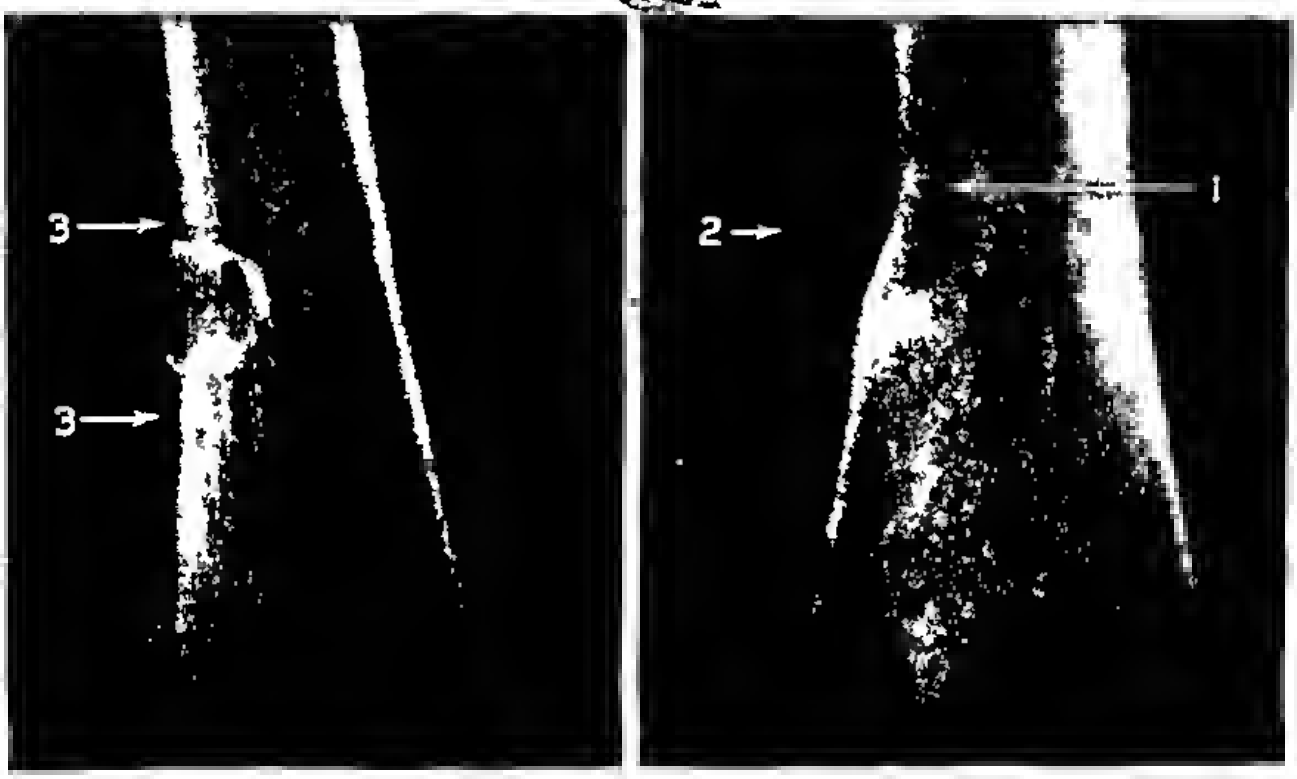


PLATE 16
Subacute Osteomyelitis (A P and Lat views)
(1) Abscess (2) Sequestrum (3) Cortitis

Characteristic changes of chronic osteomyelitis are —

(1) *Shape of bone* There is irregular increase in width of the bone shafts

(2) *Structure*
- (*a*) general rarefaction,
- (*b*) a localised area of bone destruction from infection of the cortex or cancellous bone It is surrounded by an area of osteosclerosis,
- (*c*) extensive cortical and cancellous osteosclerosis around the lesion,
- (*d*) sequestrum formation

(3) *Response of cortex* There is a marked proliferation at the level of the lesion which stretches for a variable distance above and below it The cortex is seen as a

widened structureless and dense sclerosis it is surrounded on the outside by onion peel proliferation only in the early stages

(4) *Response of cancellous bone* The cancellous bone shows sclerosis of a less dense type than in the cortex and does not spread so far along the shaft as the cortical reaction It tends to localise round the clear area of bone destruction The medullary cavity is narrowed or obliterated round the infected area

(5) *Formation of involucrum* In a variable time the affected bone area is surrounded by a shell of new bone the involucrum This is of irregular contour in which the cortex and cancellous bone are not differentiated and contains cloaca which are recognised as holes in the involucrum

(6) *Formation of sequestrum* Sequestra are seen as very dense structureless

PLATE 17
Chronic Osteomyelitis of Fibula The sequestrum has not yet been formed

PLATE 18
Chronic Osteomyelitis Note the sequestrum (*t*) in the involucrum

areas of sharp outline lying in a clear area of bone destruction or being extruded through an involucrum It is important that a sequestrum formation shall not be definitely diagnosed unless it can be shown to be free from the parent bone in two planes

Differential diagnosis

(*a*) Tuberculosis shows —

No new bone formation
No cortical reaction
No involucrum
No large sequestrum formation

(*b*) Syphilis shows —
Small areas of rarefaction gummata
Multiple bones involved with marked cortical reaction, 'onion peel' type,
No sequestrum

(*c*) Sarcoma shows —
Irregular bone destruction
No typical bone sclerosis
Sometimes irregular bone formation,

Ewing sarcoma —
Resembles osteomyelitis closely, but there is no involucrum or sequestrum formation It is very rare indeed in England

PLATE 19
Chronic Osteomyelitis showing healing stage with sclerosis

PLATE 20
Brodie's Abscess (A P view)

(*d*) Osteitis fibrosa cystica shows —
A multiple bone lesion
No periostitis
The formation of cysts,
The normal cancellous bone markings are lost and replaced by a smooth homogeneous appearance

(*e*) Osteitis deformans shows —
A multiple bone change (see page 42) of irregular sclerosing type

Appearance of healed osteomyelitis

(1) Healing may take place without any evidence of osteomyelitis This is very rare

(2) With circumscribed sclerosis This may resemble healed tuberculosis, but is located in the shafts rather than at the ends of the bones (Plate 19)

(3) With diffuse sclerosis When healed this closely resembles Paget's disease in its early stage, but affects a single bone

Atypical osteomyelitis.

(1) Brodie's abscess—a localised osteomyelitis situated typically at the lower end of the diaphysis of long bones (especially tibia) It shows an area of bone destruction surrounded by a dense ring of sclerosis The cortex is not usually affected (Plate 20)

(2) Garee type osteitis (e g post pneumonic influenzal infection of bone)

Appearance (1) The shaft of the bone is widened and spindle shaped

(2) The medullary cavity is obliterated

PLATE 21

Active Tuberculosis in Lower End of Femur Tubercular abscess (1) with a spread into epiphysis The bones are atrophied and have an out of focus appearance

PLATE 22

The same case as 21 two years later showing healing The abscess cavity has disappeared the bone structure is now normal and the outline of cortex and medulla is sharp

(3) No 'onion peel' reaction of the cortex

(4) No formation of large sequestra

(5) No localised area of bone destruction

Differential diagnosis Ewing sarcoma shows onion peel' type of reaction of the cortex

TUBERCULOSIS OF BONE

(Plates 21 and 22)

In most cases of tuberculosis of bones and joints the primary focus is epiphyseal synovial or articular manifestations are usually secondary

The epiphysis shows an area of bone destruction at its centre with associated atrophy of the diaphysis

The earliest X ray evidence of tuberculosis is a localised atrophy of the bone in the affected area, the change usually coincides with the appearance of the earliest symptoms A completely negative X ray finding does not always eliminate tuberculosis of the suspected area Because the earliest recognisable change is bone atrophy, radiographs should be taken so that the bone can be compared for equality of radiographic density with its opposite, e g both knees, the affected and the sound

Site affected. The central area of the epiphysis is most often affected Periosteal and metaphysical areas are seldom involved

Characteristic changes of tuberculosis of bone are —

(1) *Shape of bone* The shaft of the bone is not widened and is unaffected except in the later stages where softening of the bone has caused bending, as in the production of coxa vara

(2) *Structure*
- (*a*) The tuberculous bone abscess is surrounded by a narrow area of sclerosis
- (*b*) There is localised atrophy of the bone affected, with little atrophy of other bones
- (*c*) No sequestrum formation, the debris is not usually radio-opaque except in caries of the spine
- (*d*) In active disease the area of bone destruction is surrounded by a zone in which the bone trabeculations have a fuzzy, 'out-of focus' appearance
- (*e*) There is no attempt to produce new bone
- (*f*) No reaction of the cortex

(3) *Response of cortex* There is no corticular sclerosis except where the abscess is close to the surface where some localised sclerosis may take place The cortex shows marked atrophy outside the zone of sclerosis and has a "ground glass" appearance

(4) *Response of cancellous bone* The cancellous bone except for the sclerosed area surrounding the abscess, shows atrophy of a 'ground glass' type The medullary cavity is not narrowed

(5) *No sequestrum formation* There are no sequestra formed similar to those of chronic osteomyelitis unless secondary infection has taken place The debris in the abscess may show pin head opacities

Stages of healing (Plate 22)

(1) When active tuberculosis becomes inactive, the fuzzy "out-of-focus' appearance disappears

(2) The area of destroyed bone becomes smaller till it disappears

(3) The bone atrophy is replaced by normal density bone, this may take years

If healing has taken place without bone deformity, it is sometimes impossible to show that the bone has ever been tuberculous

TUBERCULOUS DACTYLITIS

This cannot be differentiated by its X ray appearance from that from other causes It affects phalanges, metacarpals, and metatarsals (see page 150)

CARIES SICCA (Plate 23)

This is a rare tuberculous infection affecting principally the shoulder joint Small multiple opaque sequestra are formed with bone destruction and local atrophy

SECONDARY INFECTION

If secondary infection takes place the appearance then becomes that of a low grade osteomyelitis with extensive osteosclerosis much deformity and small sequestra formation

Radiographically a Brodie s abscess cannot be distinguished from a tuberculous infection (Plate 20)

For tuberculous diseases of the spine (see page 126)

Differential diagnosis between osteochondritis and tuberculosis

Table showing differences

	Osteochondritis	*Tuberculosis*
Sclerosis	Marked	Absent
Atrophy	Absent	Marked
Fragmentation	Marked	Absent
Joint space	Increased or unchanged	Unchanged or decreased
Rarefaction	None	Marked
Destruction of bone	None except for fragmentation	Marked
Erosion of bone	None	Often marked
Softening of bone leading to bending	Occurs in later stage	Occurs in later stage

ACQUIRED SYPHILIS

Syphilis of bone shows itself as a multiple lesion with or without recognisable gumma formation The syphilitic bone-changes occur in the late secondary and tertiary periods of the disease

Site affected Mostly the shafts of long bones especially tibia and fibula are affected

Characteristic changes of syphilis of bones (Plate 24)

(1) *Shape of bone*

The shaft is thickened irregular and apparently bent

(2) *Structure*

(*a*) Changes in the cortex are more marked than in the cancellous bone.
(*b*) Small irregular areas of bone destruction occur in the cortex or medulla
(*c*) No sequestrum formation.
(*d*) No rarefaction

(3) *Response of cortex.* The cortex is extensively thickened along the length of the bone, which is markedly sclerosed with "onion peel" formation along its length Gummata are shown as sharp "punched-out" areas of bone-destruction close to the surface.

(4) *Response of cancellous bone.* Generalised sclerosis of the cancellous bone is not so marked as in the cortex. Narrowing of the medullary cavity takes place.

Changes in tibia. The thickening of the tibial cortex is typical, the *anterior*

PLATE 23
Caries Sicca Area of erosion indicated by arrow

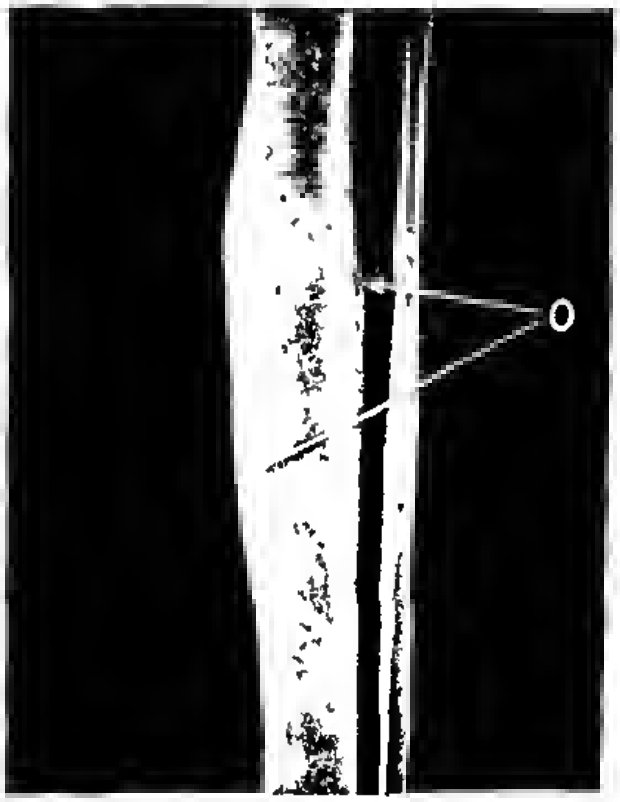


PLATE 24
Acquired Syphilis Note widening of shaft, with "onion peel" formation (O)

aspect being most affected, especially about the middle of the bone, giving the appearance of "bowing"

Differential diagnosis. In Paget's disease, the *posterior* aspect of the tibia is more thickened

Changes in the skull bones. Syphilitic changes in the skull are typical Both the inner and outer tables lose their sharp outline and have a "woolly" appearance (see page 78)

Differential diagnosis. In Paget's disease only the outer table is affected by the "woolly" appearance, the inner table remains unaffected.

Changes in bones of the hand. (See under Dactylitis, page 150) Syphilitic dactylitis is not distinguishable *per se* from tuberculous. X-ray examination of other bones

will usually distinguish between the two conditions Tuberculous dactylitis is rarely bilateral

Errors in interpretation of the normal *In an antero-posterior view, the tibia and* fibula, or the radius and ulna, may show widening of their opposing margins along the line of the interosseous membrane, which, though normal, may be mistaken for syphilitic periostitis Syphilitic periostitis of bone is best seen in lateral views

Pathological fracture *Pathological fractures may occur through a gummatous* area, which is surrounded by dense sclerosis and shows associated cortical reaction

CONGENITAL SYPHILIS

(Plates 25 and 26)

The bone changes of congenital syphilis may be the only manifestation of the disease

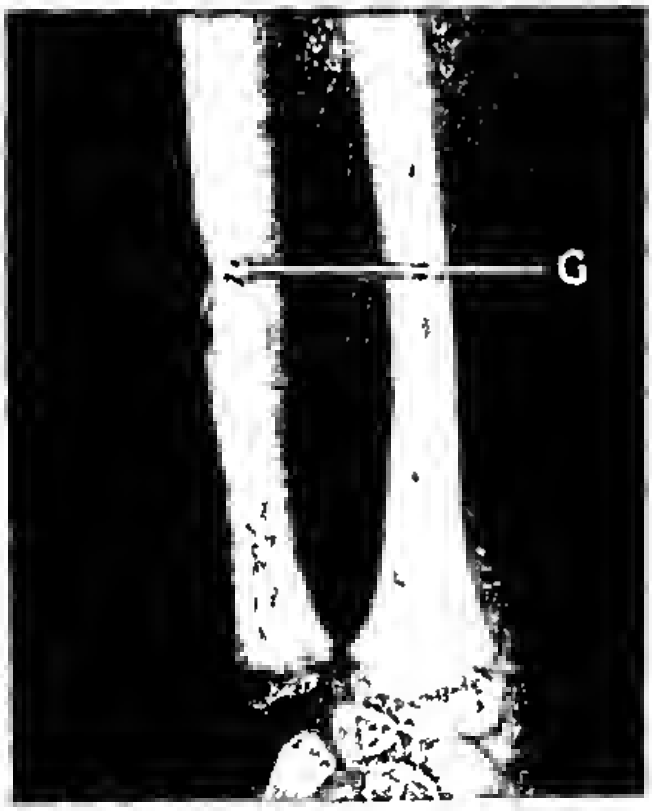


PLATE 25
Congenital Syphilis, with gumma (G) in lower half of ulna

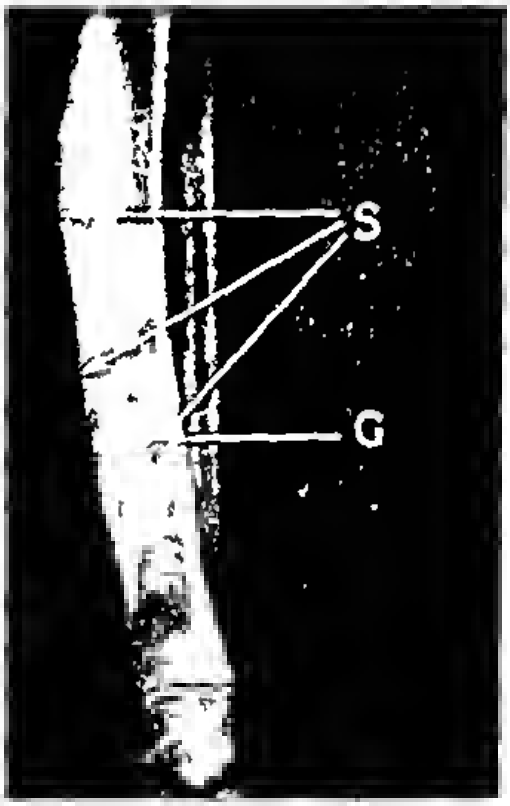


PLATE 26
Congenital Syphilis Note forward bending sclerosis (s) and gummatous area (c)

Site affected. All bones, typically long bones, especially tibia and fibula

Characteristic bone changes of congenital syphilis.

(1) *Shape of bones* Thickening and bending with lateral inequalities of growth from changes at the epiphyseal line

(2) *Structure* (*a*) "Onion peel" reaction of cortex, as in acquired syphilis

(*b*) No bone atrophy

(*c*) Bending of bones

(3) *Response of cortex* Marked cortical reaction with "onion peel" formation extending along the length of the shaft

(4) *Response of cancellous bone.* Sclerosis with occlusion of the medullary canal. Gumma occur rarely and resemble the acquired form

Syphilitic separation of epiphysis (Plate 27). Syphilitic epiphysitis is seen as irregular destruction of the bone, usually on the diaphyseal side of the epiphysis with osteosclerosis There is no diaphyseal cupping. The epiphyseal line may be slightly widened and the epiphysis displaced. "Onion peel" formation is usual in the shaft of the bone.

Skeletal deformities are produced from angulation of the epiphysis and interference with normal growth.

Differential diagnosis.

Scurvy. Peridiaphyseal reaction is marked.

Rickets Cupping of diaphysis with no peridiaphyseal reaction.

PLATE 27
Syphilitic Epiphysitis Indicated by arrow

PLATE 28
Osteitis Deformans Areas of sclerosis indicated by arrows

METABOLIC BONE LESIONS

PAGET'S DISEASE OF BONE

(OSTEITIS DEFORMANS)

(Plates 28 and 29)

A progressive disease, affecting first single bones and later the whole skeleton

Site affected. Any bone, but most often tibia, vertebral column, pelvis, skull, clavicle and femur

Characteristic changes are —

(1) *Shape of bone* Thickening and bending of shafts

(2) *Structure*

(*a*) loss of fine bone structure with the appearance of cysts

(*b*) osteosclerosis is marked

(*c*) spontaneous fracture and union occur frequently

(3) *Response of the cortex* The cortex becomes sclerosed thickened and slightly irregular, usually over the whole bone with loss of fine bone detail The changes of the cortex in the tibia are characteristic with forward bowing of the bone and thickening of the cortex on the concave side—this distinguishes it from syphilitic cortical change, which is more marked on the convex side

PLATE 9
Osteitis Deformans Note the area of sclerosis in the pelvis

PLATE 30
Osteitis Deformans undergoing sarcomatous change (osteolytic type)

(4) *Response of cancellous bone* The cancellous bone shows areas of irregular sclerosis and small cyst formation which does not however expand the bone

(5) *The Skull* Plate 83 shows the typical woolly bone formation affecting only the outer table This distinguishes the disease from syphilis of the skull which affects both inner and outer equally (see skull section page 78)

Complications

(1) Pathological fracture This shows typical Paget s disease of the bone usually with marked irregular thickening of the cortex above and below the fracture

(2) Sarcomatous change is a complication occurring in about 10 per cent of all

cases of Paget s disease It is difficult to detect unless osteoclasis of the bone can be demonstrated (Plate 30)

(3) Osteoarthritis is usually well marked in all cases of Paget s disease

Differential diagnosis

(1) *Chronic osteomyelitis* The formation of sequestrum is usually diagnostic but in the healed stage it is very difficult to distinguish from Paget s disease without knowledge of the history multiple bone involvement is more common in Paget s disease

(2) *Carcinomatosis* This can be differentiated from Paget s disease by demonstrating an area of bone destruction without sclerosis (see secondary metastases page 61)

PLATE 3
Marble Bone of Femur and Pelvis

PLATE 32
Marble Bone of Spine

MARBLE BONES

This is a very rare condition usually found accidentally during X ray examination for fracture It may affect any bone of the body (Plates 31 and 32)

Site affected The whole skeleton but may affect a single limb

Shape of bones Normal

Structure of bone The whole bone is composed of dense homogeneous compact bone without evidence of cortex and cancellous bone differentiation

Complications Fractures occur frequently as the bones are very soft

MELORHEOSTOSIS
(Plate 33)

Melorheostosis is a rare disease of bone which is included here for the sake of

completeness It shows a flowing dense cortical hyperostosis producing very dense bone which has the appearance of the outer edge of a gutted candle

Site affected Either extremity

(*a*) A single limb is affected the upper being described as showing the change more often than the lower

(*b*) The change may be either interrupted in several places or continuous throughout the extremity The continuous change starts most often in the distal parts of the limb

Characteristic changes in Melorheostosis

(1) *Shape of bone* This shows an irregular increase in the width of the shaft

(2) *Structure* Dense cortical hyperostosis

PLATE 33
Melorheostosis Note the hyperostosis

PLATE 34
Fibrocystic Disease

(3) *Response of cortex* The cortex is irregularly dense and thickened showing an uneven sclerosis of wavy outline

(4) **Response of cancellous bone** The cancellous bone shows no change

Differential diagnosis

(*a*) Marble bone disease and Paget's disease show marked change in the cortex and cancellous bone

(*b*) Calcified haematoma in which a small area only of the shaft is affected

(*c*) Ossifying cortitis of syphilis in which the cortical change is not so marked and the external borders are smooth

MULTIPLE FIBROCYSTIC DISEASE (Plate 34)
(VON RECKLINGHAUSEN'S DISEASE OF BONE)

This is a bone syndrome associated often with tumours of the parathyroid One bone alone is seldom affected

Site affected Any part of the skeleton, especially the shafts of long bones

Characteristic changes of multiple fibrocystic disease of bone are —

(1) *Shape of bone* This may show pathological fractures Some widening and bending of the shaft usually occurs

(2) *Structure*

(*a*) The formation of multiple subcortical cysts

(*b*) General osteoporosis of the whole bone

(*c*) Loss of detail in the fine bone structure

(3) *Response of cortex* The cortex is thinned with loss of detail in its fine structure

(4) *Response of cancellous bone* The cancellous tissue between cysts becomes homogeneous and structureless

INFANTILE RICKETS

Infantile rickets is a disease typified in bone by decalcification and disturbance of epiphyseal growth occurring in children up to three years of age

Site The earliest change occurs at the chondrosternal junction This is difficult to demonstrate satisfactorily in most cases

The changes in the chondrosternal junction are followed soon after by symmetrical changes in the long bones

Characteristic changes (Plate 35)

(1) *Shape* Bending of the weight-bearing bones

(2) *Structure* The bones show a general decalcification most marked at the diaphyseal ends

(3) *Cupping of the diaphyseal ends*—" wine glass deformity —with a ragged zone towards the epiphysis

(4) *Widening of the normal epiphyseal line* by absorption on the diaphyseal side

(5) *No cortical changes*

(6) *Enlargement of the medullary cavity*

Healing The ragged edge of the diaphysis becomes straightened and sclerosed The sclerosed lines persist after healing Plates 36 and 37 show active rickets and the process of healing

Complications

Early
- (1) Bending of the weight bearing bone
- (2) Greenstick fractures occur very easily

Late
- (3) Coxa vara
- (4) Genu vara

Differential diagnosis From congenital syphilis and scurvy by the cupping at the diaphysis which is found in infantile rickets alone

SCURVY IN CHILDREN (Plate 38)

A disease appearing between the third month and third year of life, affecting the ends of long bones

PLATE 35
Active Rickets The diaphysis is decalcified and shows the wine glass deformity The epiphyseal line is widened

PLATE 36
Healing Rickets The diaphysis is sclerosed and shallow

PLATE 37
Further Stage of Healing Rickets The normal bone density has returned and the cupping of diaphysis is no longer apparent

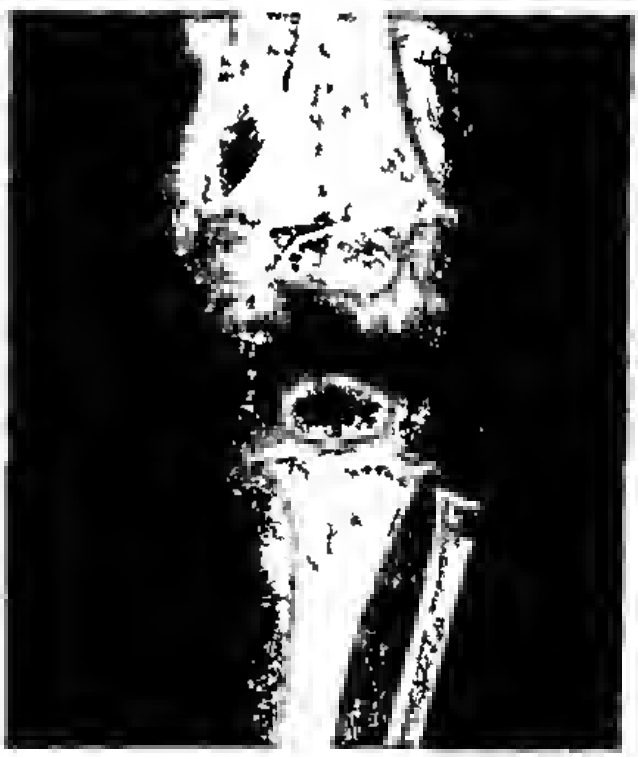


PLATE 38
Scurvy (1) Diaphyseal line showing sclerosis with line of atrophy below it. (2) Haemorrhage under periosteum is calcified. The diaphysis is widened

Site The epiphyseal-diaphyseal junction of the long bones

Characteristic bone changes

Structure (1) Sclerosis of the diaphyseal lines which are widened and slightly irregular There is an area of bone atrophy below it

(2) A general bone atrophy of 'ground glass type

(3) An area of unsymmetrical, non homogeneous opacity, produced by haemorrhage, embracing the epiphyseal line and extending down the shaft This change is only present in the advanced stages

Complications Fracture separation of the epiphysis

Differential diagnosis

(1) From early rickets which has cupping of the diaphysis

PLATE 39

Renal Rickets The change is most marked on the diaphyseal side of the epiphysis Note irregularity of epiphysis

PLATE 40

Renal Rickets Note widening of lower femoral epiphysis fracture separation and typical change

(2) From congenital syphilis which shows cortitis of the shaft of long bones and no periosteal reaction

RENAL RICKETS

The bone syndrome associated with renal rickets is of two types —

(*a*) Similar to the infantile ricket type but occurring after the age of three years

(*b*) A typical renal ricket type (Plates 39 and 40)

Changes characteristic of long bones in renal rickets (Type (*b*))

(1) *Shape* No bending or widening of the shafts of the long bones Bending occurs in the cartilagenous areas and may simulate fractures

(2) *Structure* —
(*a*) A general osteoporosis
(*b*) Obliteration of the compact bone tissue
(*c*) The diaphysis is irregular and serrated with a rat eaten appearance extending across metaphysis which is widened

(3) *Skull* It may show changes simulating Paget s disease but occurs in young people (see Paget s disease of skull)

OSTEOGENESIS IMPERFECTA (Plates 41 and 42) (OSTEOPSATHYROSIS)

A disease characterised by multiple fractures They are of two distinct types a foetal present at birth and an infantile idiopathic

PLATE 41
Osteogenes s Imperfecta (foetal type) (1) Recent f acture (2) United fracture present at b rth

PLATE 42
Osteogenes s Imperfecta (nfant le typ) The ep physes are less affected than the shafts of the bones

Types

(1) *Early*—present at birth (foetal)

(2) *Late*—infantile—occurring after the age of five years In infantile osteopsathyrosis the bones appear normal except for a very high degree of decalcification and multiple fractures

Site Any bone but especially long bones

Characteristic change Multiple fractures of the long bones and sometimes of the body of a vertebra

Structure

(1) Marked thinning and atrophy of the cortex and cancellous bone

(2) Multiple fractures producing marked deformity
(3) Rapid callus formation

ACHONDROPLASIA (Plates 43 and 44)

A familial disease produced by early union of epiphysis with a characteristic stature of the patient

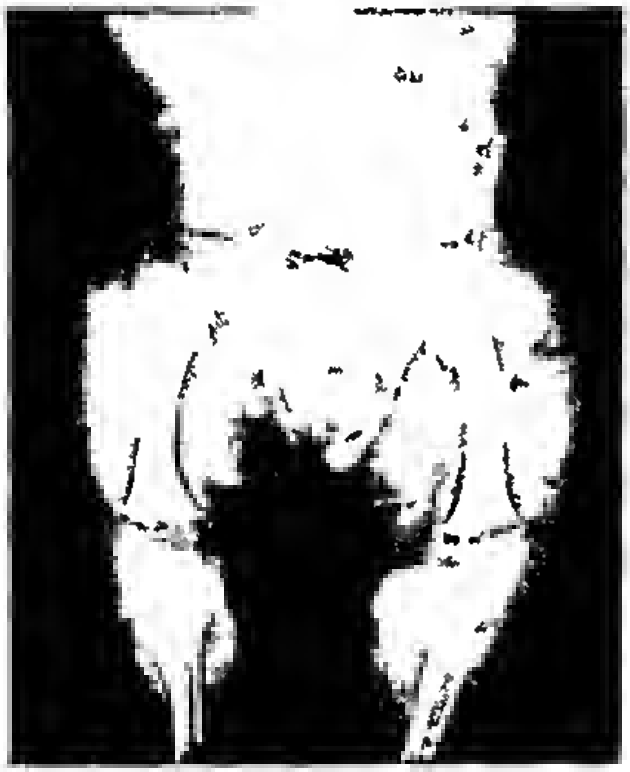


PLATE 43
Achondroplas a

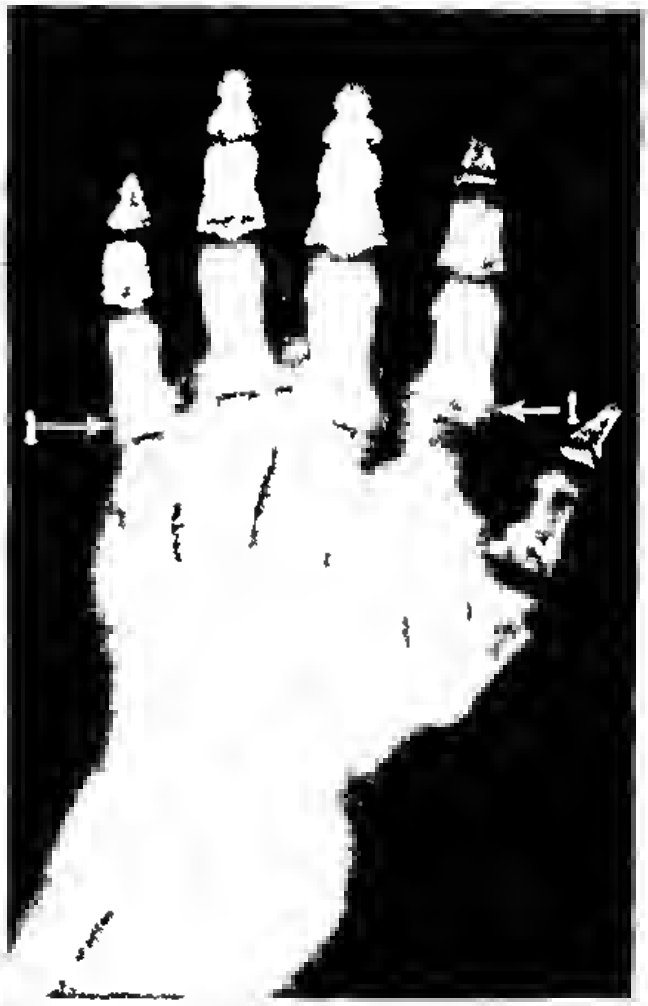


PLATE 44
Achondroplasia Note the irregularity of the epiphyses The early union of the epiphyses is most marked in the proximal phalanges (1) The carpal bones are increased in width in relation to their length

Site All bones are affected equally but it is especially noticeable in the long bones

Characteristic Changes

(1) *Early union of epiphyses*
(2) *Structure* —
  (*a*) The bones are short for the age of the patient
  (*b*) The shafts are widened
  (*c*) The diaphyseal ends of the bones are widened more than the shafts

OSTEOCHONDRITIS DEFORMANS

Osteochondritis deformans shows itself as an aseptic necrosis typically affecting certain bones through interference with the normal blood supply It is followed by spontaneous healing with deformity from weight bearing (See under bone affected)

Typical site of Osteochondritis

(1) In head of femur This is known as *Perthe s disease, Calve s disease* and *Legge s disease)*

(2) The second (third or fourth) metatarsal (*Kohler s disease Freiberg s disease*)

(3) The scaphoid of the hand or foot (*Kohler s disease*) (Plate 45)

PLATE 45
Osteochondritis of Navicular The bone is sclerosed and diminished in size

PLATE 46
Kienbock s Disease Note fragmentation of semi lunar which shows increased density and deformity

(4) The semilunar of the hand (*Kienbock s disease*) (Plate 46)

(5) The tibial epiphysis (*Schlatter s disease Osgood s disease*)

(6) A vertebral body (*Kummel s disease*)

(7) The internal tuberosity of the femur (*Osteochondritis dessicans*)

Typical structural change

(*a*) Irregular osteosclerosis of the bone

(*b*) Fragmentation of the bone

(*c*) The joint space may be increased

In the early stages of osteochondritis the radiograph may show no change from the normal although the patient may have pain and tenderness In the second stage which follows a few days later a radiograph will show an apparent increase of density

in the affected area The third stage shows the appearance of areas of rarefaction in the previously sclerosed area This is a typical change

Differential diagnosis Tuberculosis—see page 37

GOUT

(Plates 47 and 48)

The change is seen first radiographically in the hands Since calcium urate is non opaque to X rays those areas of bone in which the urate is deposited are seen as areas of increased translucency with a sharp punched out appearance

Characteristic changes Small irregular areas of sharply defined bone destruction

PLATE 47
Gout The punched-out areas indicated by arrows are urate deposits

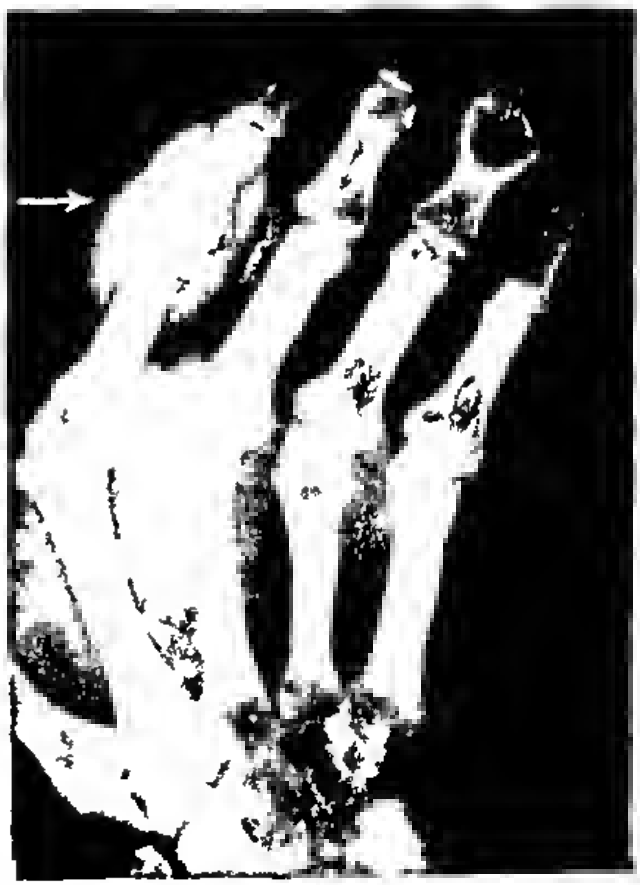


PLATE 48
A Further Stage of Gout The areas of destruction are much enlarged The area indicated by arrow is Kalkgicht

affecting heads and base of the metacarpal tarsal and phalanges at the margins of the articular surfaces chronic arthritic changes are also present

Often associated with rheumatoid changes

When secondary infection of the tophi has taken place small opaque dense shot like bodies may appear round the bones (*Kalkgicht*) (Plate 48) This is a rare change

HYPERTROPHIC PULMONARY ARTHROPATHY

(Plate 49)

A bone syndrome secondary to chronic disease of heart or lungs associated with clubbing of the fingers

Site affected Primarily the phalanges of the hands and feet but spreading from distal to proximal bones The lower end or even the whole of the radius and ulna tibia and fibula may be affected

Characteristic changes

(1) *Shape of bone* Unchanged

(2) *Structure* A general hyperplasia of the cortex affecting the bones of hands and feet equally most marked in the peripheral bones but spreading centrally

(3) *Response of cortex* Thickening of cortex

(4) *Response of cancellous bone* No change

Differential diagnosis Tuberculous or syphilitic dactylitis but these diseases do not affect all the phalanges equally

TUMOURS OF BONE

Tumours in bone may be subdivided into (*a*) **Benign** and (*b*) **Malignant**, the latter type being again subdivided into (1) *Primary* and (2) *Secondary* malignant bone tumours

The radiographs of the benign bone tumours are in most cases characteristic whereas the malignant tumours form a group which shows a wide degree of variation depending on their speed of growth and the tissue from which they are derived

The speed of growth of a bone

PLATE 49

Hypertrophic Pulmonary Arthropathy (1) The distal phalanges are tufted (2) There is thickening of the cortex of phalanges metacarpal bones radius and ulna

tumour may be judged by the reaction of the surrounding bones Where growth is rapid the surrounding bone is destroyed without any evidence of reaction or attempted repair

A slow growing bone tumour causes expansion of the surrounding bone with the appearance of coarse trabeculation in the cancellous bone of the region affected, if the periosteum is expanded by the tumour a subperiosteal layer of new bone is laid down which varies in thickness with the speed of growth and the speed of repair

The primary benign bone tumours are —

(1) Osteoma
(2) Chondroma
(3) Primary cyst
(4) Myeloma

PLATE 50
Ivory Exostosis Note exostosis occupies maxillary sinus and the anterior fossa of the skull

PLATE 51
Sessile Exostosis

OSTEOMATA

(i) Compact or ivory
(ii) Cancellous (*a*) Sessile (*b*) Pedunculated

OSTEOMA OF COMPACT TYPE (Rare)
(Plate 50)

Structure An extremely dense structureless mass of bone of smooth outline growing from the cortex without reaction of the surrounding or underlying bone Typical in ivory exostosis of skull

OSTEOMA OF CANCELLOUS TYPE (Common)
(Plate 51)

Characteristics of Cancellous Osteoma

(1) They are situated at the end of long bones

(2) They grow *out from the bone* or into the medullary cavity without any intervening zone of abnormal bone reaction The structure of the cortex and cancellous bone can be traced unbroken throughout the tumour

Site affected Most often the lower end of the femur and upper end of the tibia They also occur in the jaw and skull and in small bones of the hands and feet

TYPES

1 **Sessile exostosis** (Plate 51) appears as a boss of bone with smooth contour on

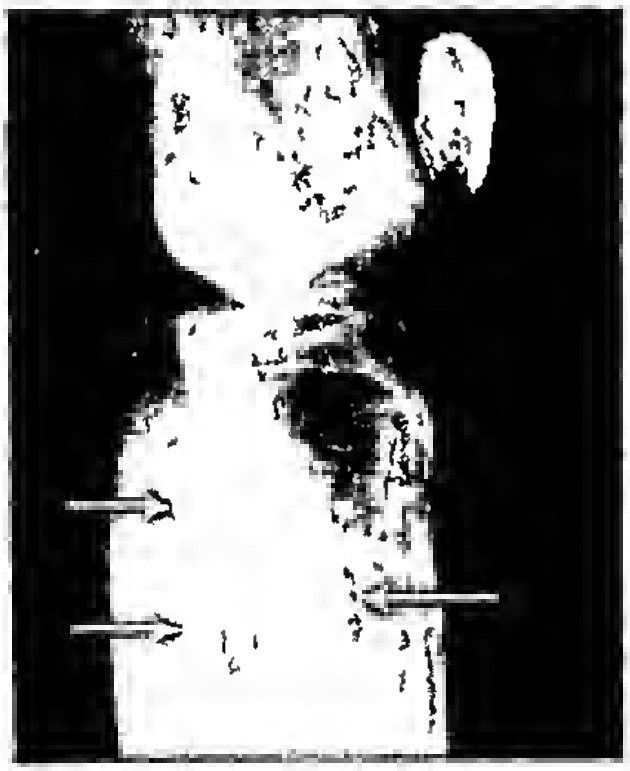


PLATE 52
Multiple Exostosis

PLATE 53
Enchondroma of Radius and First and Second Metacarpal Bones

the cortical surface of the bone The cortex and cancellous structure of normal bone are traceable without change into the osteoma

2 **Pedunculated exostosis** is similar to the sessile osteoma in structure, but pedunculated When stalked the exostosis always points away from the joints, i e in the line of the pull of the tendons

Complications

(1) They may suffer fracture from direct injury

(2) By pressure they cause erosion of adjoining bone

(3) They sometimes undergo sarcomatous changes

Multiple cartilaginous exostosis (hereditary deforming chondrodysplasia or

diaphyseal aclasia) (Plate 52) An hereditary disease in which several of the bones show exostosis usually associated with shortening of the bones and deformity of the metaphyseal ends The condition is believed to be due to congenital defects in the periosteum

CHONDROMA

The chondroma is a cartilaginous tumour

TYPES
(1) Ecchondroma
(2) Enchondroma (Plates 53 and 54)

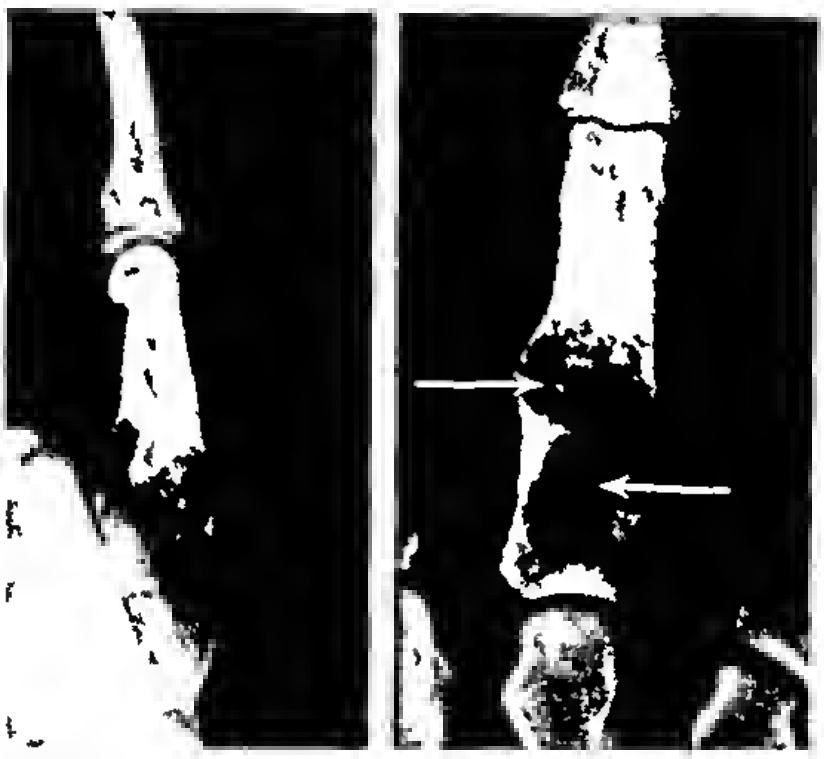


PLATE 54
Enchondroma Note opaque spots in the cyst c area

Site They are found most frequently in the hands and feet where they may be multiple They occur also in the sternum ribs and upper and lower ends of the femur

Shape of bone The normal outline of the bone is deformed by the chondroma those growing outwards from the outer surface of the bone are known as *ecchondromata* while those arising in the interior of the bone are termed *enchondromata* The enchon droma by its growth expands and erodes the surrounding bone tissue

Structure A smooth bone tumour with translucent and rarefied areas containing *small opaque spots which are diagnostic* and crossed by wide irregular trabeculations

Response of cortex In ecchondroma there is no alteration of the surrounding bone while in enchondroma the cortex is thinned and expanded but usually not fractured by the tumour They are differentiated from myelomata by the presence

of the *small opaque spots* This is a diagnostic point of the greatest importance and is found in no other bone tumour in combination with the typical trabeculation

PRIMARY BONE CYSTS (Plate 56)

Primary bone cysts are most often discovered following a pathological fracture of the affected bone Though usually single they may be multiple and must not be confused with the secondary cysts of Paget s disease and osteitis fibrosa cystica

Site They occur in the fingers and shafts of long bones the humerus femur and tibia are often affected

Characteristics of the bone cyst

(1) *Shape of bone*

PLATE 55
Chondrosarcoma the chondroma has undergone sarcomatous changes

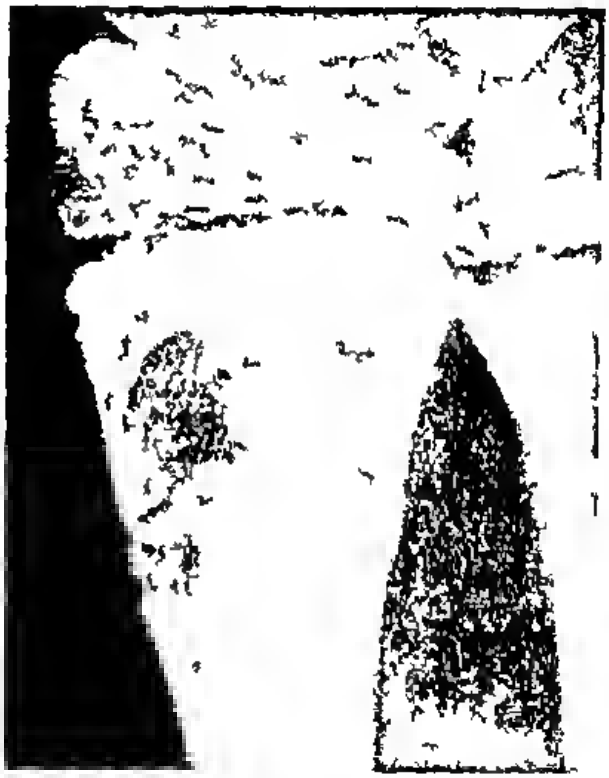


PLATE 56
Primary Bone Cyst with Fracture There is absence of sclerosis round the cyst area.

(*a*) Slightly expanded and usually fractured through the cyst
(*b*) The rest of the bone is unaffected
(*c*) The cyst itself shows a round clear translucent area

(2) *Structure* The contents of the cyst are non opaque there are no trabeculations and the shaft is only slightly expanded The wall of the cyst has a sharp outline and the surrounding bone shows no sclerosis

Differential diagnosis

(1) In a bone abscess there is sclerosis around the clear abscess space

(2) In von Recklinghausen s disease (fibrocystic disease) the cysts are multiple and both the cortex and cancellous bone show marked changes

(3) In Paget's disease the cysts are multiple and the cortex and cancellous bone show characteristic changes

MYELOMA (Plate 57)

The typical myeloma of bone is a non metastatic growth

Site. It occurs most commonly in the upper end of the tibia and frequently in the lower end of the femur, in the upper end of the humerus, and lower end of the radius and ulna

Characteristics of myeloma.

(1) *Shape of bone* It is expanded at the site of the tumour and often fractured

(2) *Structure* The tumour is a single cyst of irregular shape, crossed by coarse trabecular arrangement in which can be seen a fine structure

PLATE 57
Myeloma of Bone

(3) *Cortex* The cortex is expanded, thinned, and often fractured

(4) *Cancellous bone* The cancellous bone is atrophied around the cyst Sclerosis only takes place when healing is in progress

Differential diagnosis

(1) The coarse trabecular arrangement crossing the cyst is diagnostic in most cases

(2) The absence of the opaque spots of the chondroma (see page 56)

(3) The X ray appearance of a myeloma may be closely simulated by a slow growing fibrosarcoma which differs from it by metastasing and in which the fine structure of the trabeculae is lost It is thus of the greatest importance that the X ray film shall show perfect bone detail

MULTIPLE MYELOMATOSIS
(Plate 58)

In multiple myelomatosis there are multiple areas of bone destruction which involve a number of bones

Site The skull ribs pelvis spine and shafts of the long bones are most often affected

Characteristic changes

Shape of bone It is usually unaltered

Structure The cortex is unaffected but the cancellous bone shows multiple small sharp punched-out areas of bone destruction without trabeculation

PLATE 58

Multiple Myeloma The *punched-out* areas in the vault of the skull are very marked

and without surrounding bone sclerosis The change is typical in the skull and ribs

Differential diagnosis

(1) *Paget's disease* } In these the skull does not show clear punched out
(2) *Syphilis of bone* } areas of bone destruction

(3) *Angioma of bone* In this the appearance is similar to multiple myelomatosis but only one and adjoining bones are affected

(4) *Leukaemias* in their terminal stages (especially in children) can produce the identical picture of a multiple myelomatosis Differentiation is by the blood picture alone

SARCOMA OF BONE
(Plates 59 to 62)

A rapidly growing bone tumour of great diversity of appearance which depends on the speed of growth Bone destruction is always marked the tumour itself may or may not be calcified and over a period of months calcification may sometimes appear and disappear throughout the tumour

Site Any bone but most often the lower end of the femur

Characteristics of sarcoma

(1) *Shape of bone* There is little change in outline for the rapidly growing tumour erodes the bone too quickly to allow of much expansion

PLATE 59
Osteolytic Sarcoma

PLATE 60
Osteolytic Sarcoma

(2) *Structure* The tumours are divided arbitrarily into *osteolytic* (Plate 60) and *osteoplastic* (Plate 61) which depends on whether bone destruction or bone formation predominates Osteolytic tumours are more rapidly growing than osteoplastic The osteoplastic bone formed is irregular in outline and usually not homogeneous Some expansion of the bone may take place at the site of the tumour and a little above and below it Irregular destruction of the cortex and medulla takes place without any osteosclerosis

Where invasion of the soft tissue occurs areas of irregular calcification may appear in them at the periphery of the lesion

The formation of bone of spicule type radiating from the cortex is diagnostic of sarcoma (Plate 61)

The work of Copeland and Geschickter has shown that it is impossible to subdivide sarcomata into periosteal and endosteal from their X ray appearance alone and such X ray classification should therefore be abandoned

Ewing type of sarcoma (Plate 62) This type of sarcoma is very rare in England though it occurs more frequently in America where most of the cases have been reported

It closely resembles in appearance chronic osteomyelitis It shows areas of bone atrophy surrounded by osteosclerosis, spicule formation occurs infrequently There is no involucrum or sequestrum formation

Chondromata and bones affected by Paget's disease may undergo sarcomatous change (see pages 56 and 42)

PLATE 61
Osteoplastic Sarcoma with Spicule Formation

PLATE 62
Ewing Type of Sarcoma

SECONDARY CARCINOMA OF BONE
(Plates 63 to 65)

The appearance of secondary carcinoma in bone is not usually radiographically recognisable till from three weeks to six months after the onset of pains in the bones affected It is unusual to find involvement in bones in which the patient does not complain of pain

The lesion may appear at first to be single but since it is progressive it eventually becomes multiple

Situation

(1) Any bone

(2) The lesion appears subcortical or central beginning close to the entrance of the nutrient artery into the bone it affects most often the spine pelvis and long bones

PLATE 63
Osteolytic Carcinoma in Femur

PLATE 64

Osteoplastic Carcinomatous Deposits in Vertebrae Note in the early stages there is often no collapse

Characteristics of secondary carcinoma

Structure An irregular destruction of the normal bone, beginning usually close to the entrance of the nutrient artery The change may be osteoplastic or osteolytic, or a mixture of both

(1) **Metastases producing osteolytic changes** (Plate 63) The affected bone shows small and uneven areas of bone destruction, becoming confluent and often very extensive It is described as "worm-eaten" Pathological fracture of the bone takes place with little or no general bone reaction

(2) **Metastases producing osteoplastic changes** (Plates 64 and 65) The bone shows multiple uneven areas of osteosclerosis becoming confluent The cortex and cancellous bone becomes irregular and thickened This appearance is especially common in the healing of osteolytic metastases after X ray treatment, or in very slow-growing carcinomas, as in primary prostatic carcinoma

It is sometimes impossible to differentiate this form from Paget's disease, except by finding areas of osteolytic reaction in some part of the skeleton or from finding a definite Paget s change in the skull or other bone

(3) **Mixed osteolytic and osteoplastic changes** This is the most common variety, most often the osteolytic changes predominate over the osteoplastic

(4) **Changes in bone of carcinomatous patients without direct evidence of metastasis.** The cortex is thinned and the cancellous bone loses its robustness of outline There is marked osteoporosis and general atrophy affecting the whole skeleton This is seen in the terminal stages of patients suffering from cancer and is part of the general wasting The appearance though typical, does not mean that secondary invasion of bone has taken place, the appearance resembles senile bone atrophy

LYMPHADENOMATOUS INVOLVEMENT OF BONE

(Plates 66 to 68)

The appearance of lymphadenomatosis of bone is a typical change which in a few cases is detected before the glandular enlargements in the abdomen and neck are found Although it occurs in only about 10 per cent of cases of lymphadenoma, yet its recognition is of importance because the symptoms can be alleviated by prompt deep X ray therapy

The lesion occurs most frequently in a single bone, the vertebral column being most often affected

Situation Any bone, most often the vertebrae

Characteristic changes of lymphadenomatous involvement of bone.

(1) *Shape of bone* The bone is expanded in the region of involvement, and in the case of long bones fracture may occur Collapse of the vertebrae rarely takes place.

(2) *Structure*

(*a*) The bone shows numerous hard rounded areas of bone destruction which coalesce

(*b*) The cortex and cancellous bone are equally involved

(3) *Response of cortex* The cortex is thinned and expanded, and may be fractured A wedge of bone may be formed between one vertebra and the adjoining one The bone laid down in this formation is structureless

(4) *Response of cancellous bone* The trabeculae of the cancellous bone are expanded so that it shows numerous small rounded areas of expansion which may coalesce There is no osteosclerosis

(5) There is *no* sequestrum formation, the expansion of the trabeculae is diagnostic

Differential diagnosis (a) *Osteomyelitis* —sequestrum formation, (b) *Syphilis* — cortitis and the formation of gumma, and the presence of osteosclerosis, (c) *Sarcoma* — irregular bone destruction and no new bone formation between adjoining bones Collapse is an early sign in sarcoma of vertebra, (d) *Carcinomatous metastases* — The areas of bone destruction have a soft appearance where osteoporosis is present

DISEASE OF JOINTS

In radiography of joints, care should be taken that the outline of the joint space is as little covered as possible by the bones forming the joint This can best be obtained by seeing that the central ray from the X ray tube passes through the centre of the joint space The radiographic joint space comprises the cartilage, ligaments, synovia and synovial fluid, which are non-opaque to X-rays

Widening of the joint space is demonstrated by comparison with the width of the joint space with that of a similar non affected joint It is evidence of effusion into the joint and thickening of the synovia

The disappearance or loss of the joint space is evidence that absorption of cartilage has taken place, allowing the bone surfaces comprising the joint to come closer together or touch

ACUTE ARTHRITIS

The acute types of arthritis are —

(*a*) Acute traumatic arthritis,

(*b*) Acute non-suppurative arthritis

These conditions produce some widening of the joint space from effusion and little atrophy of bone in the early stages They may resolve without leaving any radiographic evidence, or go on to a chronic arthritis of general or specialised type

(*c*) In acute suppurative and gonorrhoeal arthritis (Plate 69) as well as widening of the joint space, there is usually marked general atrophy of the bone, most marked at the level of the capsular attachments Separation of epiphysis and dislocation may occur They usually go on to a chronic arthritis

CHRONIC ARTHRITIS

A radiograph of a case of chronic artbritis shows —

(*a*) whether the disease is still active,

(*b*) the degree of cartilaginous destruction which has taken place, and

(*c*) the production of osteophytes in the later stages

(*a*) In active chronic arthritis the sharpness of outline of the cortex of the bones forming the joint are lost, while the joint space itself appears slightly opaque The bones above and below the joint are atrophied When the condition becomes inactive, the sharpness of the bone outline reappears

(*b*) The degree of cartilaginous destruction is judged by the amount of loss of joint space and the irregularity of the bone comprising the joint which may show areas of erosion

(*c*) The edges of the bones of the joint show in most cases "lipping" or osteophytic bone formation. It is especially marked on the bone edges taking part in the joint formation and more marked in the larger than in the smaller joints

As a result of these changes, the joint space may be diminished or obliterated Under the term chronic arthritis are included both rheumatoid and osteoarthritis

OSTEOARTHRITIS (Plate 70)

This joint change is most marked in the larger joints There is an irregular loss of the joint space with osteophytic new bone formation, but little or no bone atrophy In advanced osteoarthritis, marked hypertrophy of bone around the capsule may take place, leading often to partial dislocation This is seen particularly often in osteoarthritis of the hip True ankylosis rarely occurs except in the spine when the term spondylitis is used

PLATE 65
Osteoplastic Carcinomatous Deposits with Collapse of 1st Lumbar Vertebra

PLATE 66
Lymphadenomatous Deposits in Spine Arrow indicates area of erosion New bone formation bridging intervertebral space

POLYARTICULAR RHEUMATOID ARTHRITIS (Plate 71)

This affects most frequently the small bones of the hands and feet

(*a*) In the acute stage, the joint space has a "fuzzy" appearance with loss of the normal sharpness of the bone structure

(*b*) In the early chronic stage, there is irregular loss of the joint space, sparse osteophytic formation, and thinning of the cortex, with a 'ghost" appearance of the bone

(*c*) In the later stages of the disease, contraction of tendons produces dislocation, with areas of erosion around the heads and bases of the bones

FORMATION OF LOOSE BODIES

Loose bodies in the joint spaces are seen most frequently in the knee

Care must be taken not to confuse a loose body with the sesamoid bone, which is in the tendon of gastrocnemius muscle behind the knee (see Knee, page 124)

Regions in which loose bodies are frequently found are —

(1) knee,

(2) elbow

PLATE 67
Lymphadenomatous Deposit in Spine
Arrow indicates area of erosion

PLATE 68
Destruction of Clavicle by Lymphadenoma

Types of loose bodies

(1) 'Melon seed" bodies associated with chronic synovitis

(2) Post-traumatic loose bodies, from injury to

(*a*) articular cartilage,

(*b*) ecchondrosis of osteoarthritis

(*c*) an epiphysis

(3) Loose bodies occur in bursae, and are most common in the subdeltoid space of the shoulder These can only be seen in their true relation in stereoscopic views when the loose bodies are seen to lie outside the joint space

TUBERCULOUS ARTHRITIS

This may be either —

(*a*) Primary synovial or

(*b*) Secondary to a primary bone lesion (Plate 21)

PLATE 69
Gonorrhoeal Arthritis. Note the atrophic line at the level of the capsular attachments

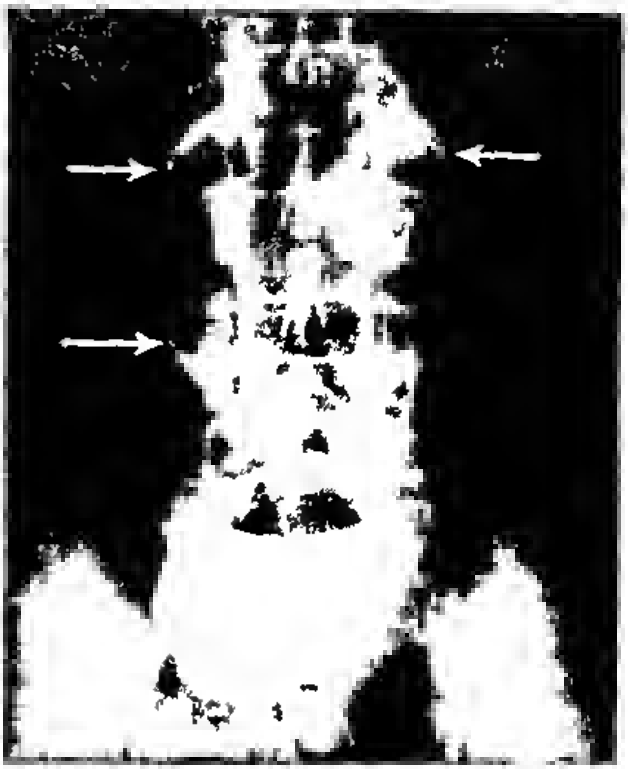


PLATE 70
Osteoarthritis of Spine (Spondylitis). Osteophytes indicated by arrows

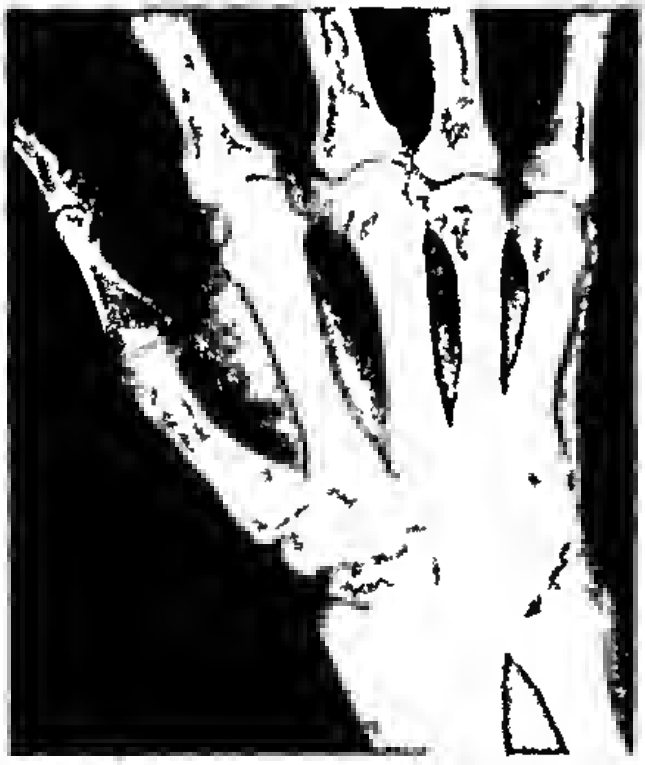


PLATE 71
Chronic Polyarticular Arthritis. Note the loss of bone density and narrowing of all joint spaces

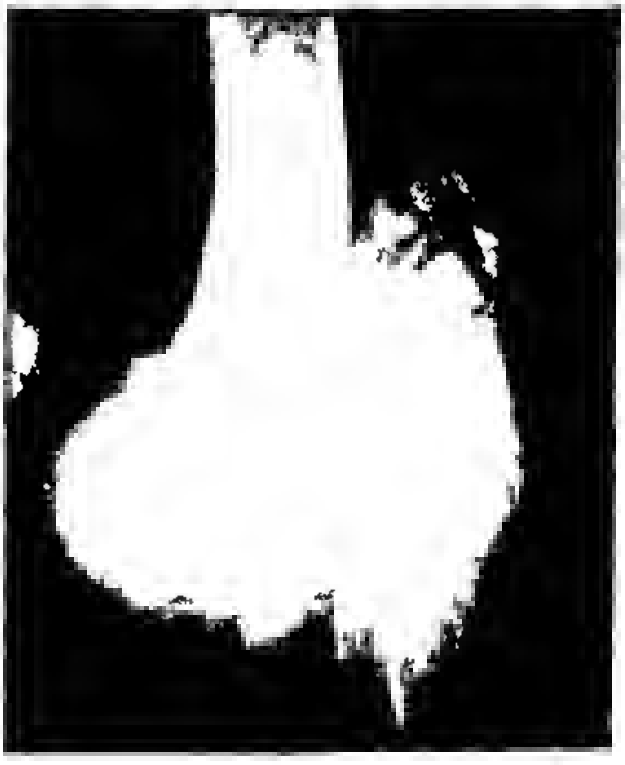


PLATE 72
Charcot's Disease of Knee Joint

(*a*) In primary tuberculosis of the joint, there is widening, at first, of the joint space, with very marked bone atrophy

(*b*) In secondary tuberculosis of the joint, the primary bone lesion is usually seen to communicate by a band of atrophied or destroyed bone, with the joint space which shows the changes of a chronic arthritis

Primary tuberculous arthritis is, *per se*, in its early stages radiographically often indistinguishable from other forms of arthritis As the disease progresses, the bone atrophy increases, and the bone develops a typical ground glass type of atrophy The joint space becomes diminished with destruction of cartilage until it is obliterated The seat of infection is most often synovial and gives rise to marked bone atrophy, with a "ground glass" appearance of the bones forming the joint

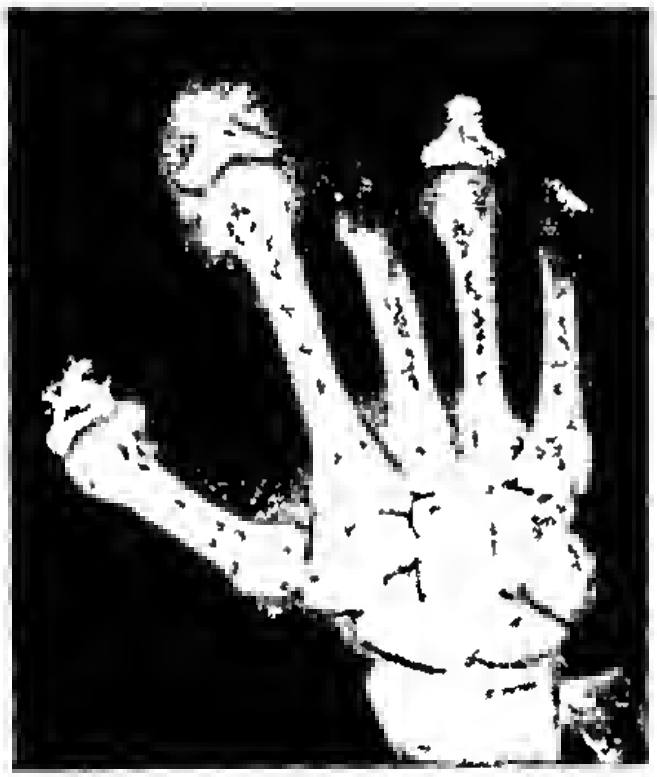


PLATE 73

Leprosy Note loss of phalanges but little bone atrophy

PLATE 74

Syringomyelia Note bone atrophy most marked in distal phalanges dislocation and loss of phalanges

NEUROPATHIC JOINT CHANGES (CHARCOT'S DISEASE)

The common causes of a neuropathic joint change are —

(1) Tabes dorsalis, affecting most often the large joints

(2) Syringomyelia and leprosy, affecting mostly the joints of the hands and feet

NEUROPATHIC CHANGES IN LARGE JOINTS (Plate 72)

(*a*) A general osteosclerosis of the bone ends forming the joint

(*b*) An irregular osteophytic formation, as in osteoarthritis

(*c*) Extensive cartilage and bone erosion of irregular type within the joint capsule.
(*d*) The formation of large loose bodies of irregular outline with some degree of dislocation.

NEUROPATHIC CHANGES IN SMALL JOINTS

(Plates 73 and 74)

(*a*) Extensive erosion of the ends of the bones, but little general bone atrophy.
(*b*) Dislocation at the joints.
(*c*) No osteosclerosis.
(*d*) The formation of sequestra.

Plate 73 is a case of leprosy; Plate 74 syringomyelia.

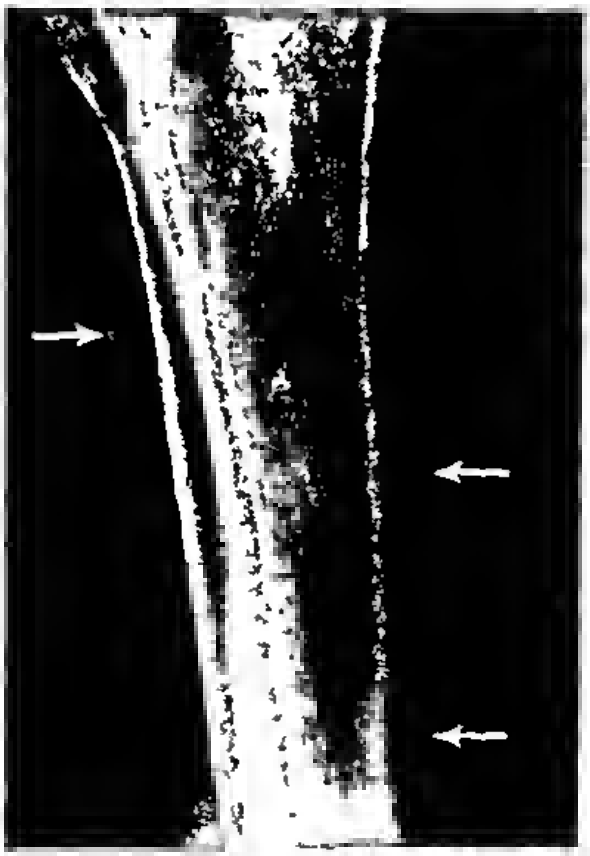


PLATE 75
Cysticerci in Muscle, marked with arrows

CYSTICERCI

Cysticerci (Plate 75) Calcified cysticerci from the tape-worm of pork can be seen in man as multiple, homogeneous, dense shadows varying in size from 2 to 6 mm. or more. They are most easily seen in the muscles of the neck, thigh and leg. In the thigh and leg they must not be confused with phleboliths, which have a harder ring outline and lie in the line of the main vessels, whereas the cysticercus lies in any of the muscles

BONES AND JOINTS (REGIONAL)

CHAPTER III

BONES AND JOINTS (REGIONAL)

THE SKULL

The most informative view of the general topography of the skull is the lateral view, and it should be stereoscopic

The observer must first estimate whether the skull has been taken 'straight,' i e whether a line joining the two infraorbital ridges would be at right-angles to the plane of the film, in which case, the lamina cribrosa should be seen as a single line If tilting of the head is present the lamina cribrosa line will be duplicated and undue distortion will be present

The skull is composed of a number of semi-flat bones lying in different planes In a lateral view of the vault the bones are seen as consisting of an inner and an outer table of homogeneous structure and between them is seen bone structure of lighter density which shows faint spiculation When the inner table appears to fade into the outer table, or to be increased in thickness, this is usually due to projection of a partly tilted plane on to the plate

Any apparent changes of density in the occipital region appearing in a lateral picture should be disregarded, because of distortion resulting from the shape of the skull in this region and its relation to the plate and X-ray tube Changes of density in the occipital region should only be diagnosed from the basal view, which throws the base as a flat surface on to the film Any estimation of thickening of the bones of the skull should only be made from the lateral view at the top of the vault An apparent thickening of the skull in the occipital region is likely to be due to distortion

The following should be recognised in the lateral pictures (Plate 76) —

(1) The sutures between bones and the presence of wormian bones
(2) The groove of the middle meningeal artery and its branches
(3) The sella turcica and sphenoidal sinuses
(4) The mastoid cells
(5) The sphenoparietal and transverse sinus.
(6) The frontal and maxillary sinuses
(7) The calcification of the pineal body, if present

The occipito frontal view is of importance when it can be shown that a calcified pineal body has been deviated to the right or left by an intracranial tumour In order that deviation can be proved, it is important that the picture shall show the crista galli and nasal septum lying in the same straight line to prove that the skull has been taken 'straight"

In the basal view (Plate 77) the following should be recognised —

(1) The foramen magnum
(2) The mastoid cells.
(3) The petrous part of the temporal bone
(4) The external occipital protuberance
(5) The parieto-occipital suture
(6) Sometimes the internal acoustic foramina may also be seen

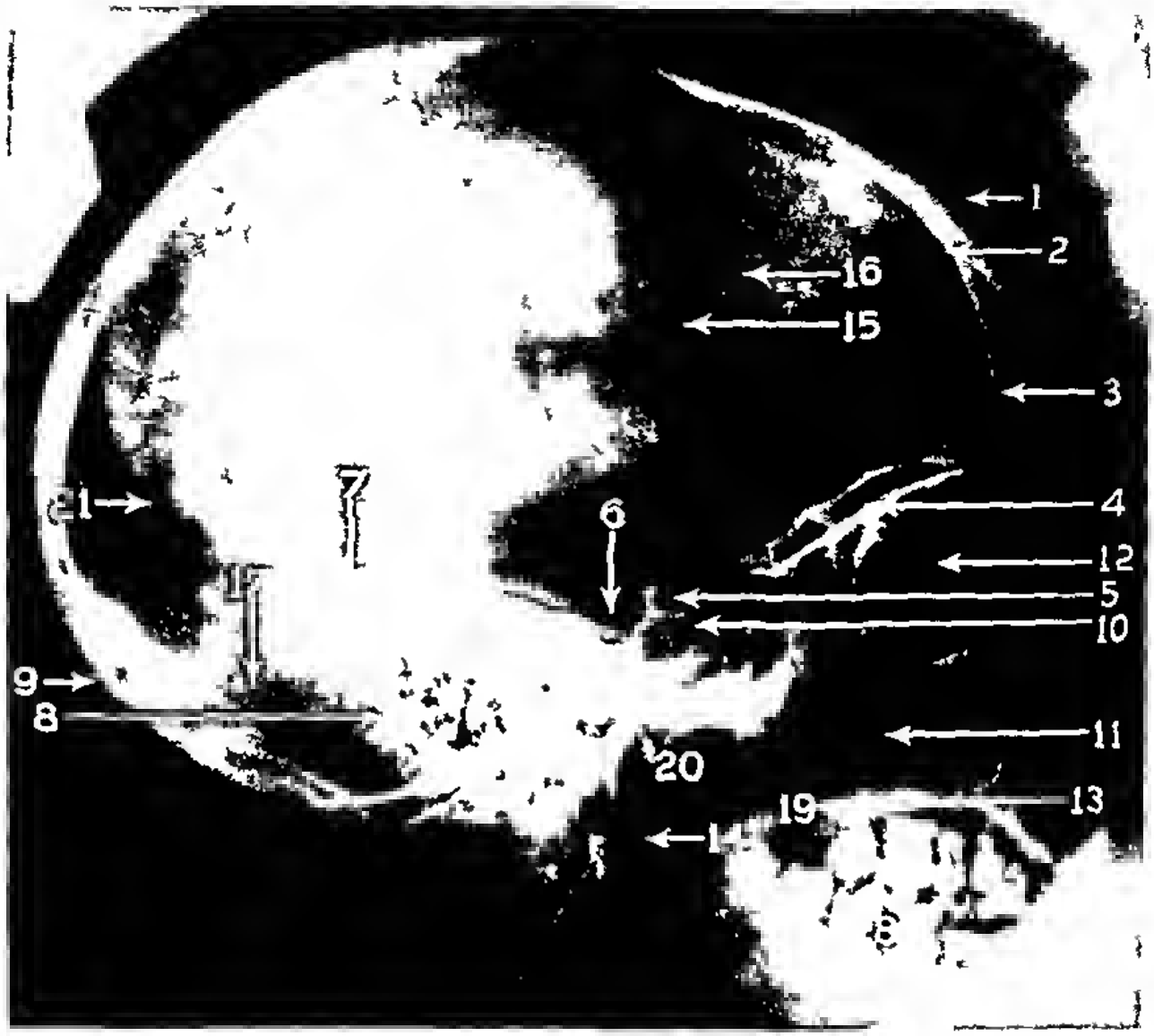


PLATE 76

Lateral View of Skull

(1) Outer table of skull
(2) Inner
(3) Frontal sinuses
(4) Lam na cribrosa
(5) Sella turcica
(6) Clivus
(7) Crista petrosa
(8) Masto d process (pneumatic sed)
(9) External occ p tal protuberance
(10) Spheno d sinus
(11) Maxillary s nus
(12) Orbit
(13) Maxillary palatine process.
(14) Styloid process
(15) Spheno parietal suture
(16) Groove of m ddle meningeal artery
(17) Transverse sinus
(18) Body of mandible
(19) Corono d process of mandible
(20) Condyle of mandible
(21) Lambdo d suture

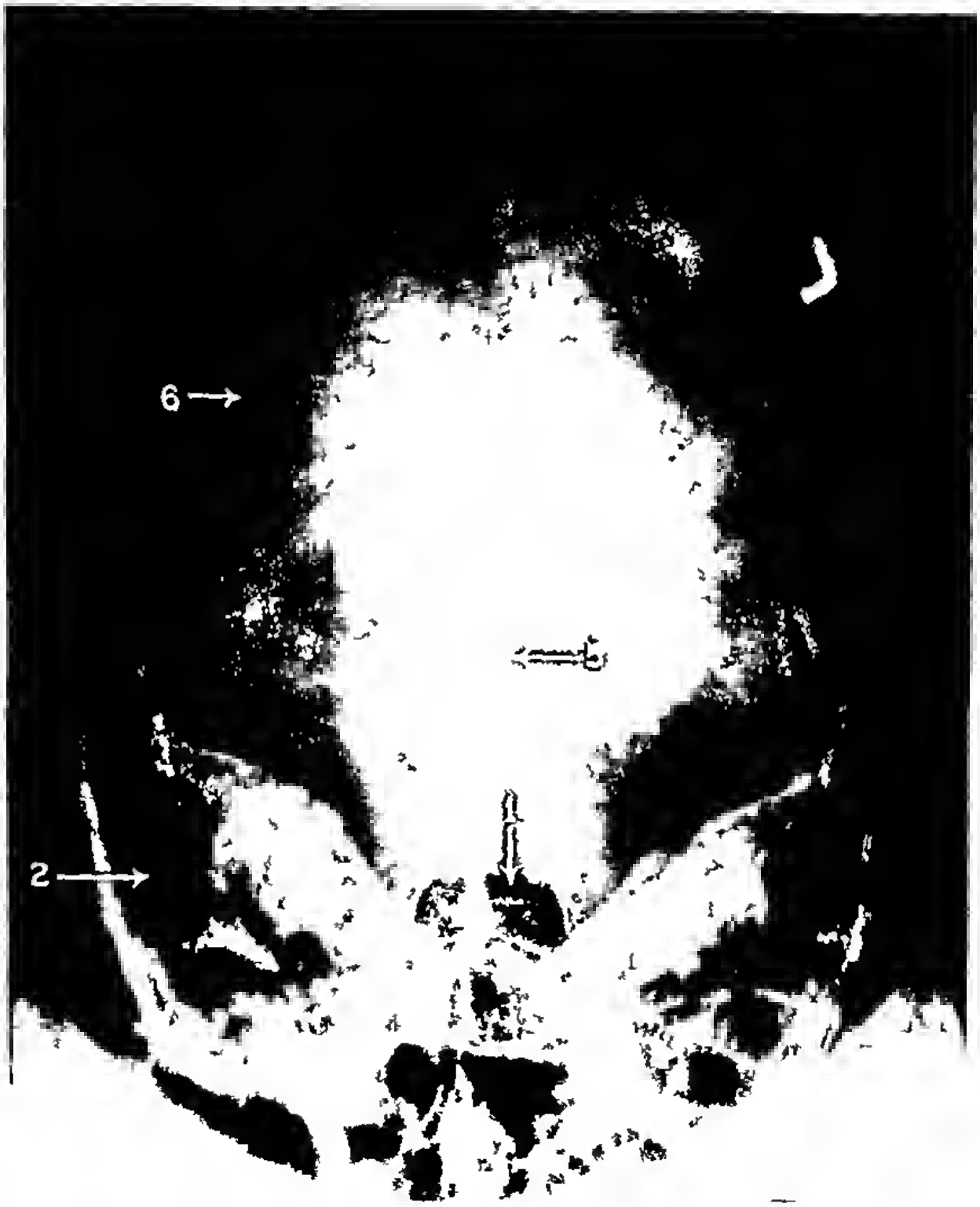


PLATE 77

Base of Skull

(1) Foramen magnum
(2) Mastoid cells
(3) Petrous part of temporal bone
(4) External occip tal protuberance
(5) Nuchal line
(6) Pareto-occ p tal suture

Sutures show a great variety in the time of closing, the posterior end of the sagittal suture is usually closed at the fortieth year, the coronal at the fiftieth

FOETAL SKULL

The outline of the foetal skull can be seen in utero at the end of the third month of intra uterine life Gross overlapping of the skull bones in the fronto-parietal and occipito parietal areas is evidence of foetal death (See page 246 on Death of the Foetus)

PLATE 78
Increased Intracranial Pressure The finger marking or beaten silver change is very marked

INCREASED INTRACRANIAL PRESSURE
(Plate 78)

The beaten silver skull is evidence of increased intracranial pressure This appearance is produced by the pressure of the brain on the vault of the skull, which becomes thinned from pressure of the brain, so that the outline of the convolutions can be seen The more marked the change, the longer standing is the condition The change is localised in the early stages, but later becomes general When it is localised it is some indication of the region of the tumour The "beaten silver" appearance is found associated with —

(*a*) Intracranial tumours
(*b*) Hydrocephalus of children when the sutures are open
(*c*) Oxycephaly, in which the sutures are closed

DEVELOPMENTAL ABNORMALITIES OF THE SKULL

Micro- and megalocephalus show no peculiar bone change except in the dimensions of the skull and the very marked thinning of the vault in megalocephalus

ACROMEGALIC SKULL

(See under Pituitary Fossa, page 80)

In this condition, as well as the changes in the pituitary fossa, the frontal sinuses are increased in prominence and the jaw is of prognathous type

PLATE 79

Multiple Fractures of Skull Note the 'hard' outline of the fractured line (1) as opposed to 'soft' outline of suture (2)

FRACTURE OF SKULL

(Plate 79)

Fractures of the skull are shown as straight lines with a "harder" appearance than any other marking of the skull and must not be confused with unclosed sutures, which are, however, spiculated

Fractures of the base of the skull can rarely be distinguished except where a fracture line can be traced from the vault of the skull running into the base

A depressed fracture is best shown

(*a*) Stereoscopically, when the depressed bone can be seen

(*b*) By obtaining a profile view

The evidence of fracture of the skull is most useful in the early stages after fracture, but, because of the general condition of the patient, it is most difficult to obtain these

radiographs satisfactorily, as they require close co-operation between the patient and the radiologist.

INFECTIVE BONE LESIONS OF SKULL

Acute osteomyelitis. No bone change is seen.

Chronic osteomyelitis. This shows areas of dense sclerosis and circumscribing areas of osteolysis.

Progress. There is a gradual return to normal with extrusion of the sequestra if formed.

Tuberculosis. The changes cannot be distinguished from those of chronic osteomyelitis.

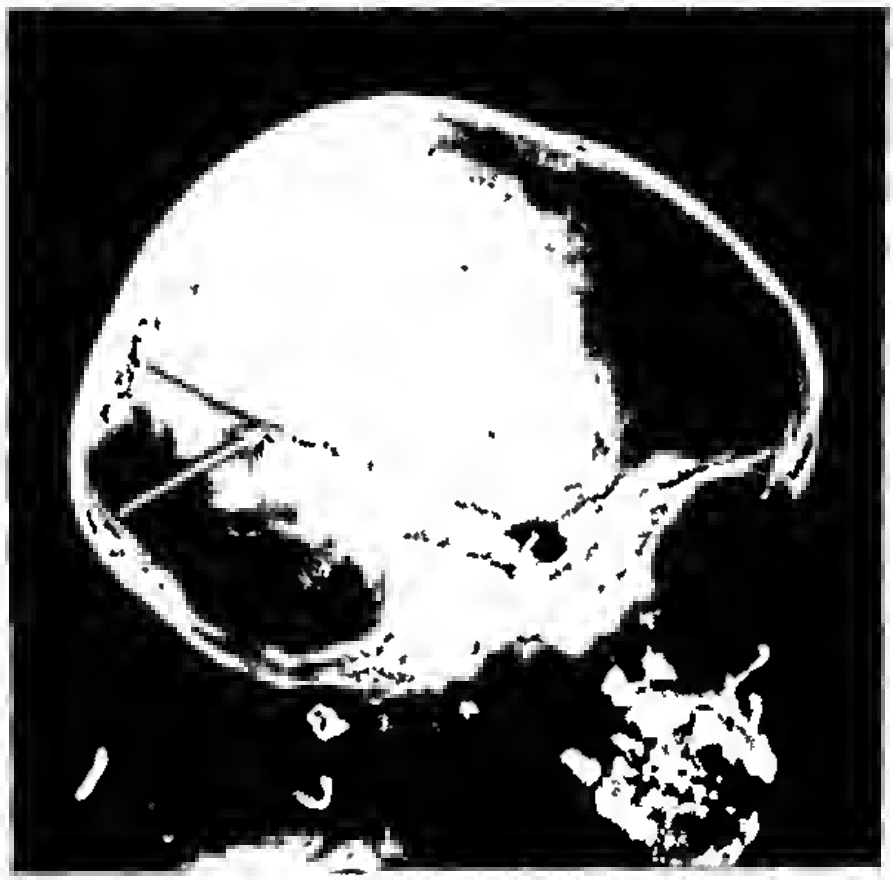


PLATE 79A.
Fracture of Skull indicated by arrow.

Syphilis of the skull (Plate 80). The appearance is somewhat similar to that of Paget's disease, but both inner and outer tables are affected by "woolly" bone appearance (see Paget's disease, page 79). This change in both tables is diagnostic.

SPECIAL INFECTIVE LESIONS PRODUCING SCLEROSIS OF THE BASE OF THE SKULL

There is a group of rare diseases, such as *Leontiasis ossia* (Plate 81) and *Goundou disease* (Plate 82), in which the main change occurs in the base of the skull, extending to the bones of the face. The change is in the nature of an osteosclerosis.

METABOLIC DISEASES CAUSING CHANGES IN THE SKULL

PAGET'S DISEASE—OSTEITIS DEFORMANS (see page 42)
(Plate 83)

Part affected Most marked in the vault

Characteristic It affects only the outer table the outline of the inner table being unaffected

Contour of bone There is irregular patchy overgrowth of the skull bones, with general loss of bone detail affecting the outer table

Changes in bone structure Multiple areas of *osteoporosis* and *osteosclerosis* occur with the appearance of small tufts of cotton wool studding the vault

PLATE 80
Syphilis of Skull Note the osteosclerosis and that both tables of the vault are affected

In the *early stage* the change may begin in any part of the vault

In the *late stage* the whole skull becomes affected

A very infrequent change is the replacement of a large area of the bone table most frequently in the parietal region by a dense plaque of sclerosed bone (see Plate 84)

Differential diagnosis

(1) *Syphilis* may produce the same change in the bone structure but the *inner table* as well as the outer table is affected (Plate 80)

(2) *Carcinomatosis* shows areas of osteolysis (most noticeable in the vault) with little bone sclerosis The contour of the tables often remains unaffected but may be expanded (Plate 85)

(3) *Multiple myelomatosis* shows multiple punched out areas of osteolysis in the skull with no loss of general bone detail (Plate 34)

SCURVY AND INFANTILE RICKETS

The appearance of the skull is not diagnostic

MARBLE BONES

The skull is opaque all over its vault the tables cannot be differentiated The other bones usually show a similar change

Differential diagnosis If the differential diagnosis is uncertain it may be elucidated by radiographs of other bones where the condition may affect other parts of the skeleton as in Paget s disease Syphilis and Multiple Myeloma

PLATE 81

Leontiasis Ossea Note the osteosclerosis affecting chiefly the anterior half of the skull

RENAL RICKETS

The skull shows circular areas of decalcification—the outline of the outer table is lost This combined with changes in the epiphyseal regions of the long bones is diagnostic

THE SELLA TURCICA

(Plate 76)

The shape of the sella turcica in the lateral view of the skull is oval or round and its contours are regular It is bounded in front and above by the anterior clinoid process and behind by the posterior clinoid process The anterior clinoid process is projected in the lateral view with a blunt point The shape of the posterior clinoid process varies much within normal limits and may appear to be separated from its base but it is not abnormal unless erosion of the process is demonstrated The average measurements of the sella are 8 mm deep and 12 mm long

PATHOLOGICAL CHANGES OF THE SELLA TURCICA

Effects of intra and extra sellar tumours on the shape of the sella turcica are —

(*a*) In the interglenoid space separation of the clinoid processes occurs without alterations in the lower part of the sella turcica

(*b*) In supra sellar growths growing into the sella the sella appears shallow from erosion of the anterior and posterior clinoid processes and is only deepened by very large tumours

PLATE 82

Goundou Disease Note the generalised osteosclerosis which affects the skull vault as well as the base

(*c*) Intra sellar growths produce irregular erosion of the floor of the sella turcica

(*x*) Acromegaly (Plates 86 to 88)

(*a*) In the *early stages* the shape of the sella turcica becomes reniform but the distance between the anterior and posterior clinoid processes remains unchanged The sella is deepened

(*b*) *In the later stages* the downward enlargement increases

(*c*) In the *last stage* the downward enlargement increases and separation takes place between the anterior and posterior clinoid processes The posterior clinoid process may be broken off and displaced backwards and the floor is depressed into the sphenoidal sinuses

Associated changes in the skull

(1) Prognathism of the jaw There is an alteration of the angle of the jaw which becomes more obtuse the lower jaw projecting in front of the upper

(11) Gross hypertrophy of frontal area with enlargement of the frontal air sinuses

(2) **Causes of erosion and fracture of the posterior clinoid process**

(*a*) Growths in the post nasal space invading the sphenoidal sinus The presence of the growth is confirmed by demonstrating a tumour in the nasal space and opacity of the sphenoidal sinuses

(*b*) Acoustic tumours are confirmed by clinical signs and erosion of the petrous part of the temporal bone round the internal acoustic meatus (see page 93)

(*c*) Basal tumours are confirmed by clinical signs

PLATE 83

Paget's Disease of Skull The tufting is very marked the outline of the outer table is irregular the inner table remains intact and regular

(3) Erosion and fracture displacement of one anterior clinoid process with monolateral exophthalmos is evidence usually of an aneurysm of the Circle of Willis It can only be proved by a thorotrast filling of the Circle of Willis to demonstrate the presence of the aneurysm (Plate 89) This is a procedure not to be undertaken lightly

INTRACRANIAL CALCIFICATION

Intracranial calcifications can be recognised in stereoscopic examination of the lateral projection of the skull

Abnormal intracranial calcification can only be diagnosed when the group of "normal" intracranial calcifications have been eliminated

I NORMAL INTRACRANIAL CALCIFICATIONS

(1) The pineal body is calcified in 60 per cent of adult skulls This calcification, varies in size from a single dot to an irregular area 5 mm in diameter It lies directly above the mastoid cells on a level with the centre of the bony orbits

(2) The choroid plexus when calcified is seen as a semicircle of opaque dots above the posterior part of the temporal bone

(3) The falx cerebri in the lateral view of the skull may show irregular calcification, often of circular outline, lying between the crista galli in front and the surface of the tentorium behind (Plate 90)

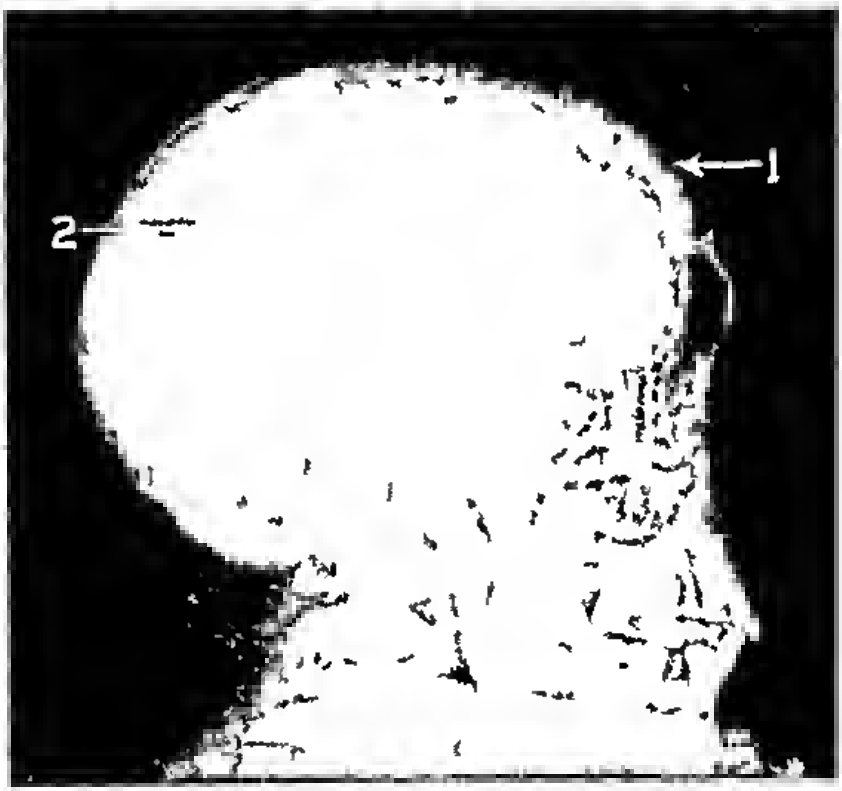


PLATE 84.
Paget's Disease of Skull Showing Atypical Change (1) Typical change in frontal area (2) Area of sclerosed bone in temporo parietal region

(4) Opacities in the line of the longitudinal sinus are produced by calcification in the Pacchionian bodies

II ABNORMAL INTRACRANIAL CALCIFICATIONS

(1) Calcifying intracranial tumour (Plate 91)
(2) Abscesses
(3) Cysts
(4) Teratoma
(5) Haemangioma undergoing calcification (Plate 92)

PLATE 85
Carcinomato is Deposit in Bones of Skull indicated by arrows

PLATE 86
Pituitary Tumour (Stage 1) Note the reniform shape of sella

PLATE 87
Tumour in P tuitary fossa (Stage 2) Note the whole fossa is enlarged and the roof of the spheno d s nus is deformed

PLATE 88
Acromegaly (Stage 3) Note the whole fossa is enlarged with depression into the sphenoid sinus which is obliterated

Differential diagnosis can only be arrived at by collateral evidence because of the inconsistency of the radiographic appearances Sometimes the diagnosis can only be made at operation

THE NASAL SINUSES OF THE SKULL
(Plates 92A to 101)

The nasal cavity and its accessory sinuses are of prime importance to the

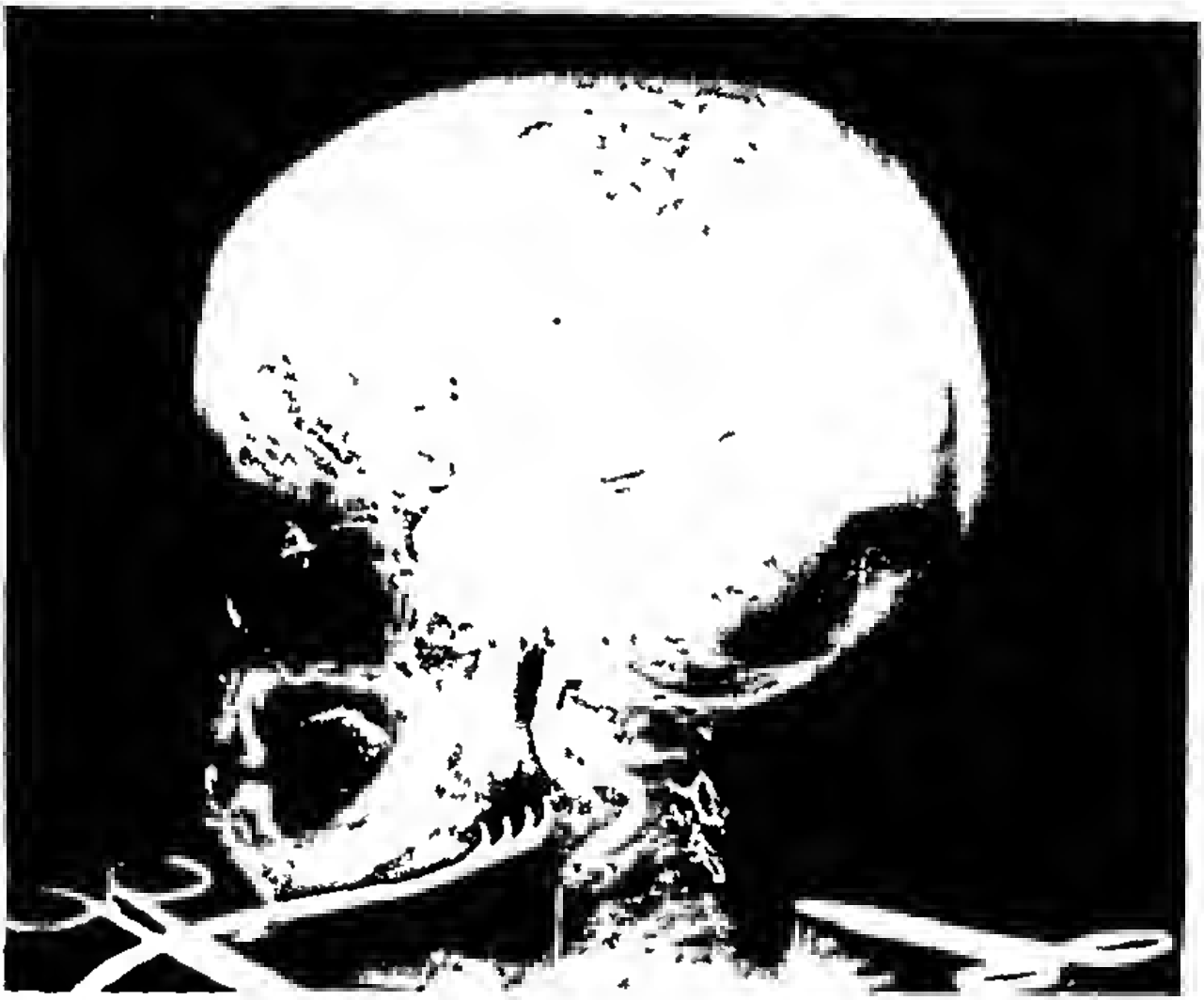


PLATE 89
Skull Aneurysm of Circle of Willis

radiologist because they are frequently the site of infective processes which can most early be detected by radiographic investigation

Sinus infection, as well as giving rise to the intermittent discharge of pus from the nose, can produce an intractable neuralgia, sometimes wrongly diagnosed as true trigeminal neuralgia, and also lead to chronic bronchitis from the discharge passing into the lungs *via* the throat Occasionally it may give rise to conjunctivitis and iritis

The nasal septum forms a wall between the right and left sides of the nasal cavity above and in front lie the frontal sinuses the ethmoid cells lie in a lateral position the sphenoid cells behind and above The maxillary sinuses are lateral to the ethmoid cell groups

The frontal sinuses lie between the two tables of the frontal bone and are usually asymmetrical They extend upwards to a varying degree Generally they are more developed in the male than in the female in whom they may often be absent on one or both sides While they are fully developed at about the fourteenth year they often do not appear until the age of seven years

The ethmoid cells are an irregular group of air sinuses which are very variable in number and extent from case to case Though anatomically divided into an anterior

PLATE 90
Calcification in Falx Cerebri indicated by arrow
A P view

a middle and a posterior group radiographically they are more often described as only an anterior and posterior group the middle group of cells being included with the anterior group

The anterior group of cells lie behind the frontal process of the maxilla and form part of the lateral wall of the orbit The posterior cells lie further back and form the postero-lateral and medial part of the posterior orbital wall

The sphenoid sinuses lie in the body of the sphenoid bone In front lies the nasal cavity above the sella turcica laterally the anterior part of the middle cranial fossa and posteriorly the basal part of the occipital bone and the posterior fossa The sinuses are usually irregular in size and extend backwards into the sphenoidal bone to a very varying degree

The maxillary sinuses lie within the body of the superior maxilla They are

usually symmetrical and can first be seen after about the second year. In the postero-anterior radiograph they are seen as pyramidal areas, with the apex pointing downwards and the base forming the floor of the orbit.

The variations from the normal which can be recognised are :—

(1) Deviation of the nasal septum.

(2) Differences of opacity between one set of sinuses and another.

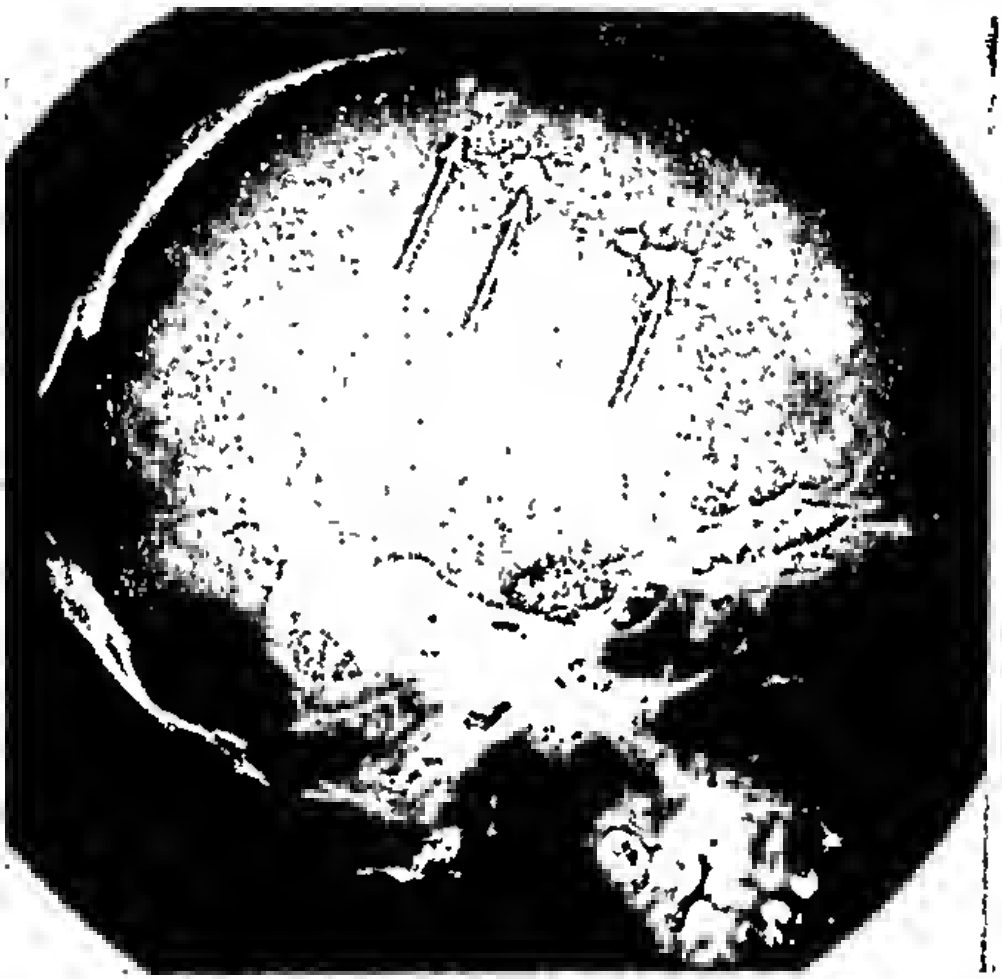


PLATE 91.

Calcification in intracranial tumour. Note the heavily calcified areas in the upper vault.

(3) Equal but increased opacity of all sinuses.

(4) The appearance of fluid levels.

(5) The invasion of sinuses by tumours, with distortion of the sinus outline.

The diagnosis of infection of a sinus depends on the recognition of loss in the normal translucency and the normal sharpness of the bone forming the wall of the sinus.

The types of opacity in the sinuses are divided into :—

(1) Thickening of the mucous membrane.

(2) Effusion with or without a fluid level.

(3) Complete opacity of the sinus.

The presence of the fluid level is demonstrated by tilting the head in the horizontal position to one side and showing that the fluid level remains horizontal.

The diagnosis of abnormal conditions in the nasal sinuses depends on the recognition of the loss of normal translucency and changes in the walls forming the sinus.

The radiograph must be taken so that the translucency of the sinus is not impaired by structures forming the base of the skull, which may give rise to mistaken interpretation of an intra-sinus opacity.

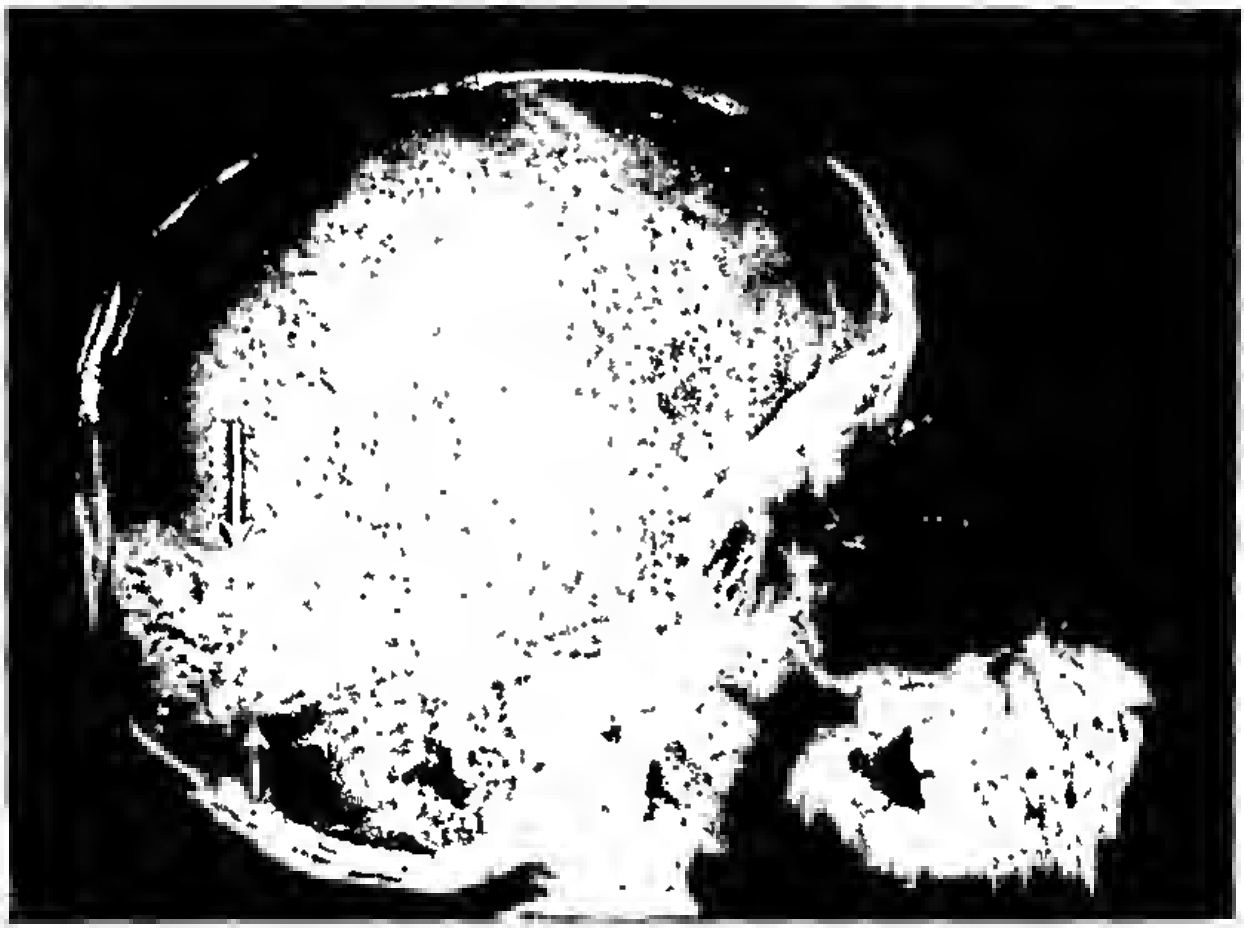


PLATE 92.
Calcification of Haemangioma in Posterior Fossa of Skull, indicated by arrows.

Projection for frontal cells (Plate 94).

The frontal cells are projected by a ray parallel to Reid's base line and passing through the external occipital protuberance.

Projection for maxillary sinuses (Plates 92A and 95).

The maxillary sinuses are projected by a ray passing through the sinus at 45° to Reid's base line, the head being tilted up at this angle to project the petrous part of the temporal bone below the base of the maxillary sinus. The X-ray tube is centred 5 cm. above the external occipital protuberance.

Projection for sphenoidal sinuses (Plates 93 and 96).

Sphenoidal sinuses are projected by a ray passing at right-angles to Reid's base line and bisecting it.

Projection of ethmoidal cells.

From the frontal cell projection the anterior and posterior ethmoid cells are superimposed upon each other From the maxillary sinus projection, the anterior ethmoid cells alone are seen, the posterior ethmoid cells being projected downwards

From the sphenoidal sinus projection, the ethmoid cells are seen lying between the mandible in front and sphenoidal sinus behind

Diagnosis of pathological conditions in nasal sinuses.

(1) Complete opacity (Plate 97) replacing normal translucency indicates swelling of the mucous membrane from thickening, infection or (rarely) new growth

(2) In the upright position, sometimes a fluid level may be seen indicating infection (Plate 98) , a fluid level is associated with mucous secretion rather than pus

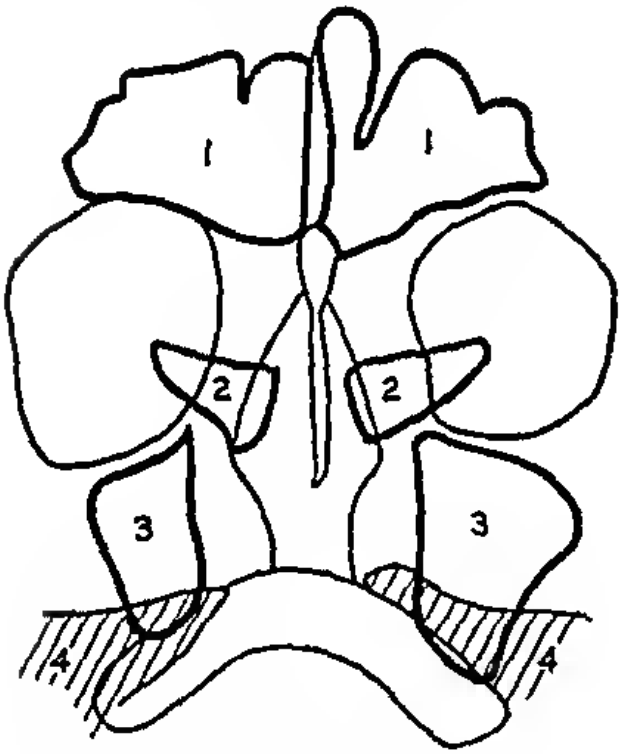


PLATE 92A
Nasal Sinuses of Skull (Maxillary projection)
(1) Frontal sinuses
(2) Ethmoid cells.
(3) Maxillary sinuses
(4) Petrous part of temporal bone projected at base of maxillary sinus.

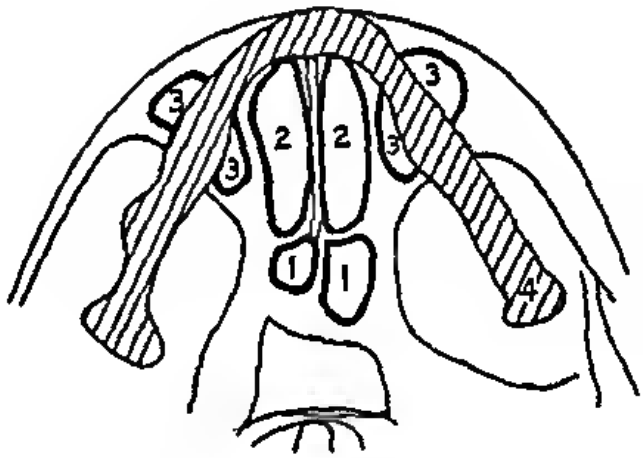


PLATE 93
Nasal Sinuses of Skull (Submaxillary projection)
(1) Sphenoid sinuses (3) Maxillary sinuses
(2) Ethmoid cells (4) Mandible

(3) Slight opacity more marked at the base and sides of the sinus indicates swelling of the mucous membrane without definite effusion (Plate 100)

(4) A localised swelling of the mucous membrane indicates a polyp (Plate 99)

(5) In chronic infective processes, the sharp outline of the bone wall is lost

(6) Sclerosis of the bone around the margin of the sinus indicates chronic osteomyelitis

(7) A densely opaque homogeneous opacity in a sinus is usually produced by an osteoma (Plate 101)

The normal mucous membrane lining the sinuses cannot be seen, it is visible only when it is swollen

MASTOID CELLS (after Schuller)

The size of the mastoid cells varies much from one individual to another They are seen as a grape-like area lying behind the condyloid process of the jaw, which is an easily recognisable landmark

PLATE 94

Frontal Cells as seen by Frontal Projection

(1) Frontal sinus
( ) Maxillary sinus
(3 Ethmoid sinuses
(4) Orbit.
(5) Petrous part of temporal bone projected into lower part of orbit
(6) Zygoma

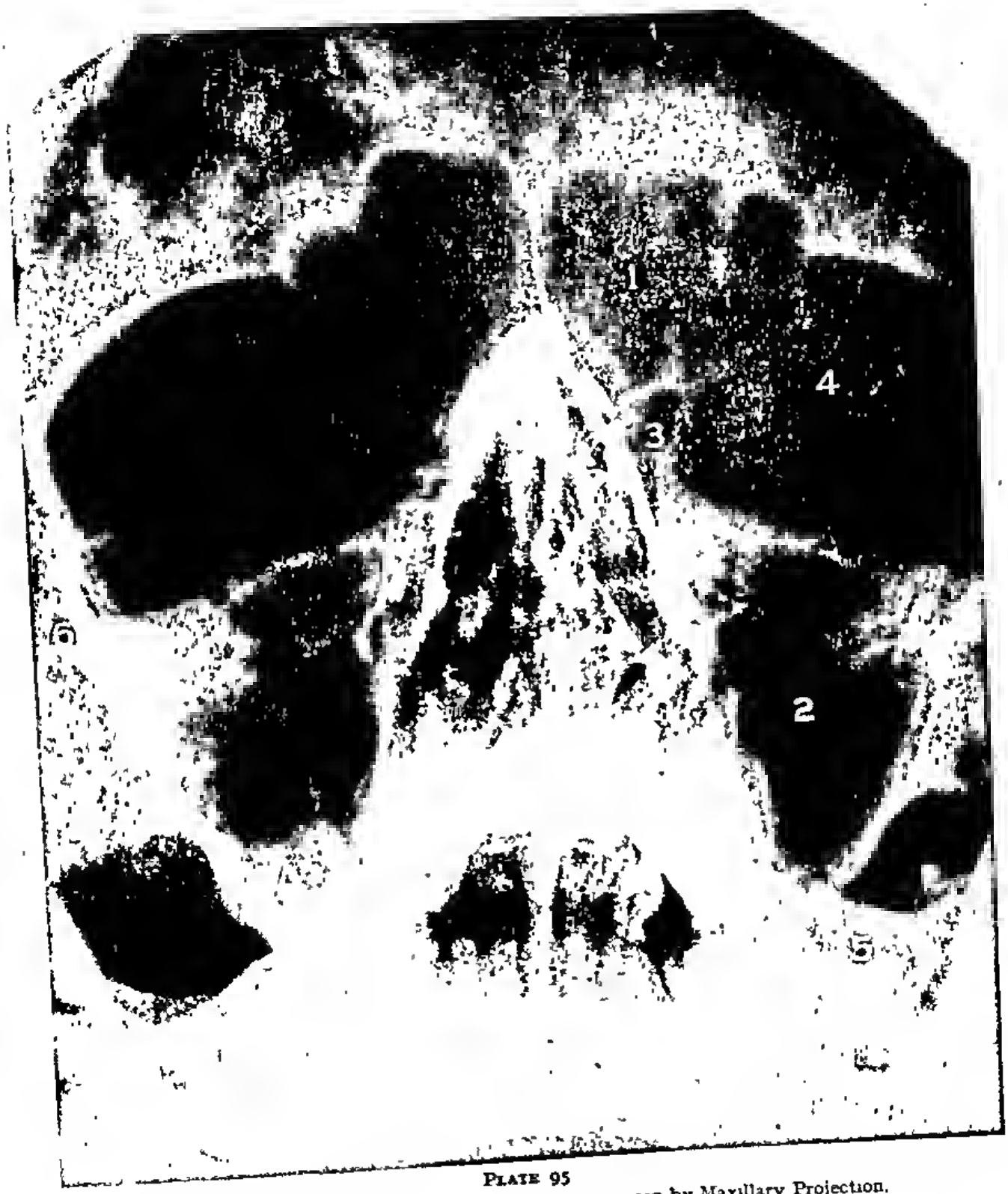


PLATE 95

Maxillary, Frontal and Ethmoid Sinuses as seen by Maxillary Projection.

(1) Frontal sinus.
(2) Maxillary sinus.
(3) Ethmoid sinuses.
(4) Orbit.
(5) Petrous part of temporal bone projected below maxillary sinus.
(6) Zygoma.

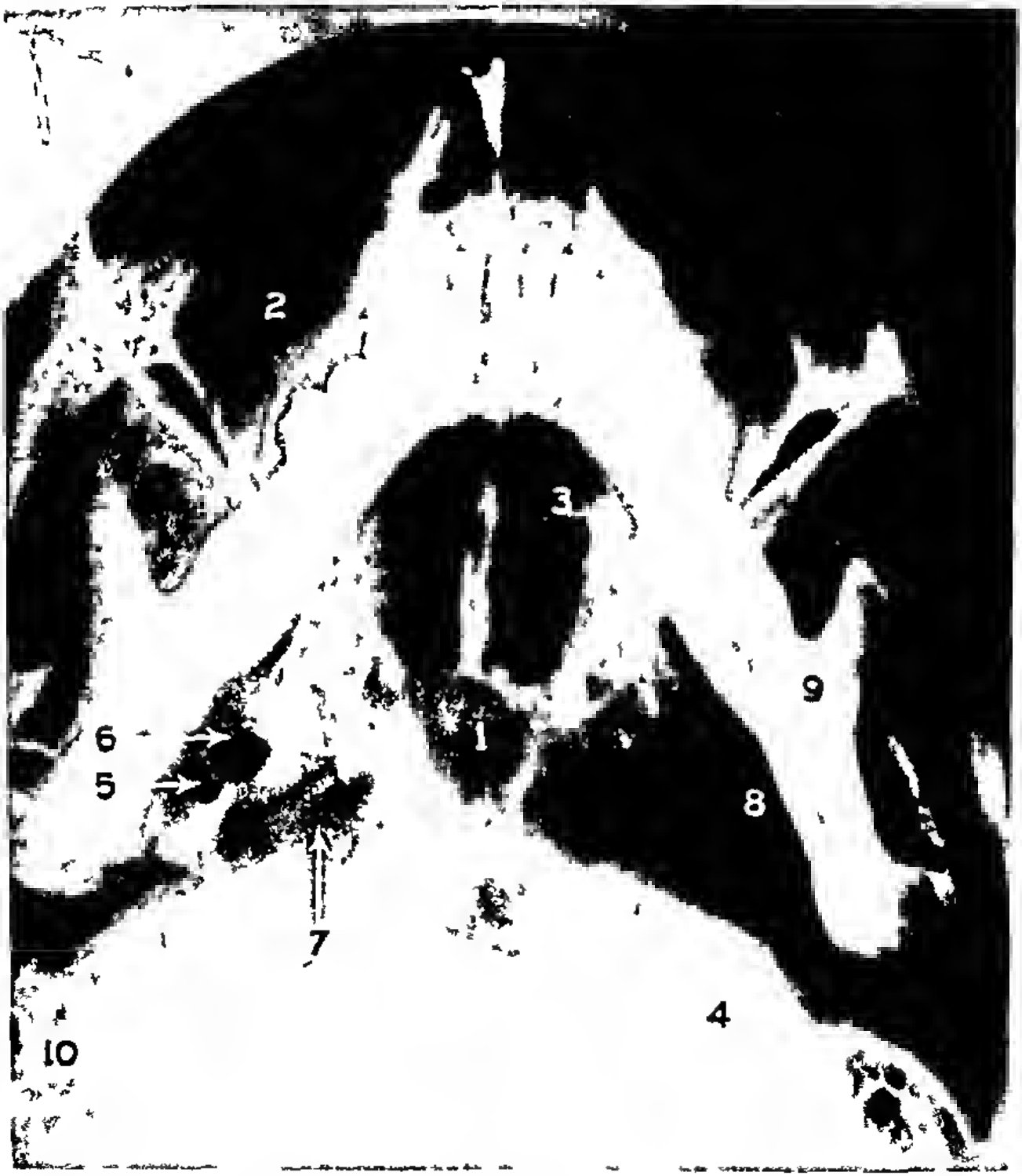


PLATE 96

Sphenoid and Ethmoid Cells from Sphenoid Projection

(1) Sphenoid sinus.
(2) Maxillary sinus
(3) Ethmoid cells middle and posterior group
(4) Petrous part of temporal bone
(5) Foramen spinosum
(6) Foramen ovale.
(7) Foramen lacerum
(8) Greater wing of sphenoid
(9) Mandible
(10) Mastoid cells.

The normal mastoid cells are translucent loss of translucency is evidence of infection Both groups of mastoid cells should be X rayed so that comparison of translucency may be made

Plate 102 shows normal mastoid cells and Plate 103 infected cells of the other side In the early stage of infection the mastoid cells are not opaque The change is similar to that in osteomyelitis in that there is no demonstrable change in the early acute stage As the infection becomes chronic the cells become opaque and their sharp outline destroyed

TUMOURS OF THE ACOUSTIC NERVE

Tumours of the acoustic nerve may produce changes in the petrous part of the temporal bone which can be radiographically demonstrated

PLATE 97
Opaque Maxillary Sinus Infection indicated by arrow

PLATE 98
Fluid Level in Right Maxillary Sinus indicated by arrow

The tumour in most cases enlarges the internal acoustic meatus Evidence of the enlargement can only be obtained by comparing it with the meatus on the other side The most satisfactory projections are a view showing the base of the skull and the petrous part of both temporal bones (Plate 105) and the Stenver projection (Plates 104 and 106)

X RAY EXAMINATION OF THE TEETH

In X ray examination of the teeth a series of intra oral films are used as on each film it is only possible to show two or three teeth The method of notation of the teeth in each region is shown in Plate 107

Because of the differences in the angle of the plane of the teeth and the palate the

path of the X-ray must be directed to produce the minimum distortion to prevent apparent lengthening or foreshortening of the teeth The path of the rays must fall at right angles to the imaginary bisecting plane formed with the hard palate, as shown in Plate 108

The parts of the tooth recognisable are shown in Plate 109 The normal alveolar margin reaches the neck of the tooth and the pericementum can be traced in unbroken line around the root The teeth must be examined for evidence of infection, faulty fillings and pulpstones

Care must be taken not to confuse the normal foramina, canals and antra with changes at the roots of the teeth If doubt exists, an oblique view of the tooth will alter the relation of the root to the suspected area

PLATE 99
Polyp in Left Maxillary Sinus.

In pyorrhoea (Plate 110), there is absorption and recession of the alveolar margin from the neck of the teeth, in the most advanced cases the roots appear to lie free of the alveolus, with usually a heavy deposit of deep tartar

Chronic apical infection (Plate 111) The earliest change is increase in width of the periodontal space round the tooth apex Later, destruction of the cancellous tissue round the root occurs The cancellous tissue only shows sclerosis in cases of long-standing infection

Pulpstones These are seen as round, opaque dots lying in the pulp cavity they are evidence of degenerative changes in the pulp cavity and are rare

Dentigerous cysts (Plate 112) are most common in the molar region The tooth

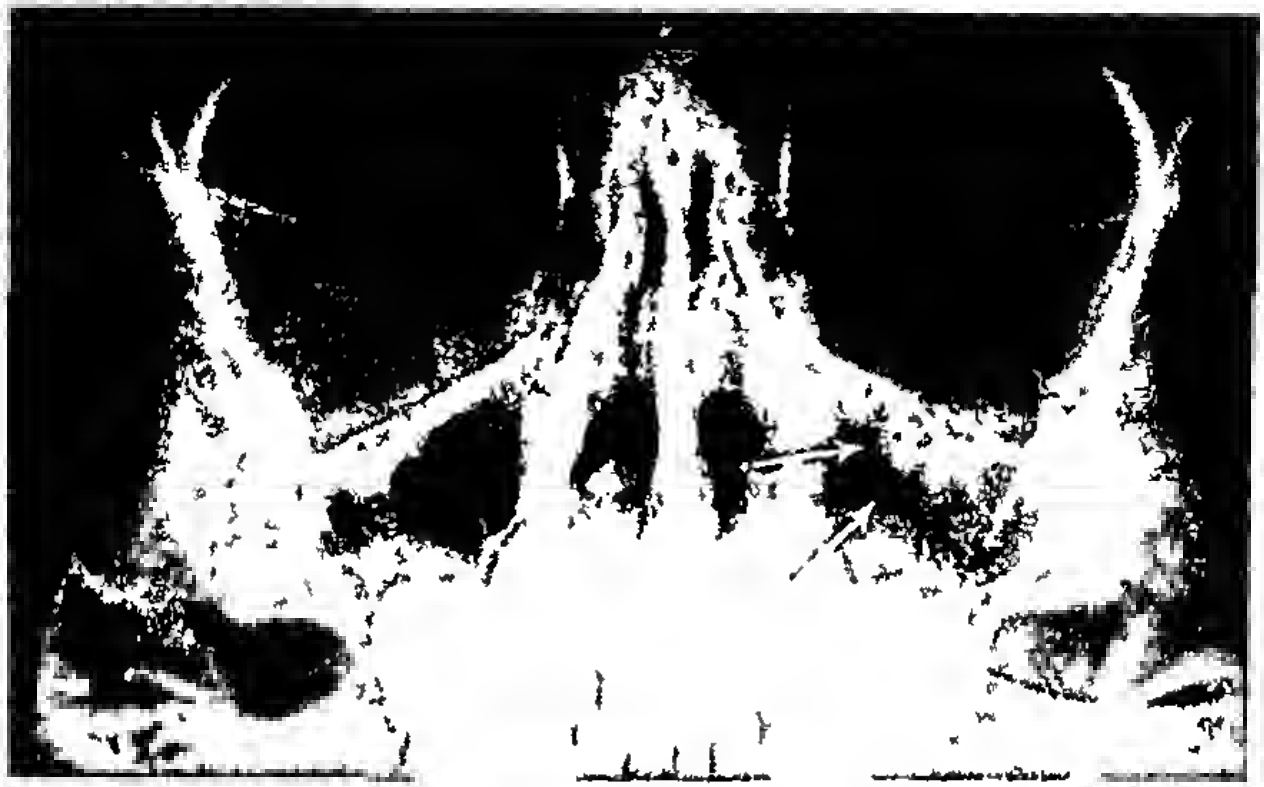


PLATE 100
Thickening of Mucous Membrane of Left Maxillary Sinus

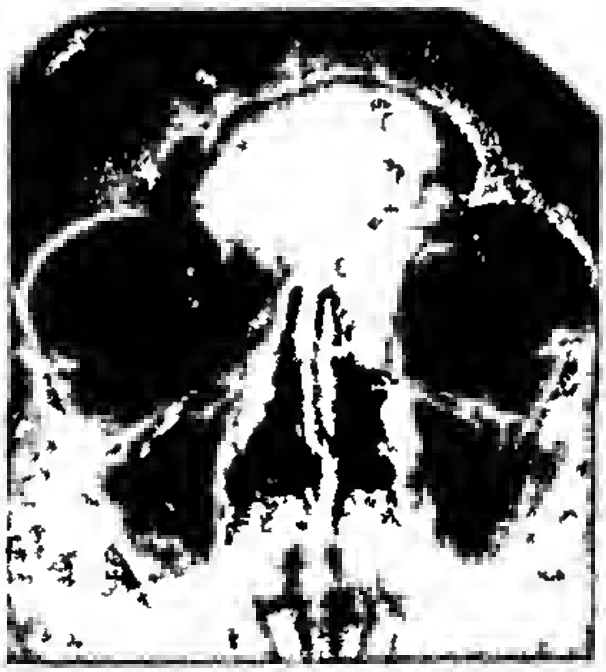


PLATE 101
Ivory Exostosis in Frontal Cells

usually distorted, lies in the cyst cavity, its crown often being in contact with the wall of the cyst

Dental cysts are rarified areas found most often attached to the roots of dead teeth They have a well defined wall and may cause expansion of the alveolus

SPINE

A general survey of the spine should always include lateral views as well as antero-posterior views, and stereoscopic pairs in the upper thoracic area, because the outline of the scapula throws confusing shadows in the lateral radiographs

Antero-posterior views of the first, second and third cervical vertebrae should be taken through the open mouth in order to avoid the shadow thrown by the lower jaw

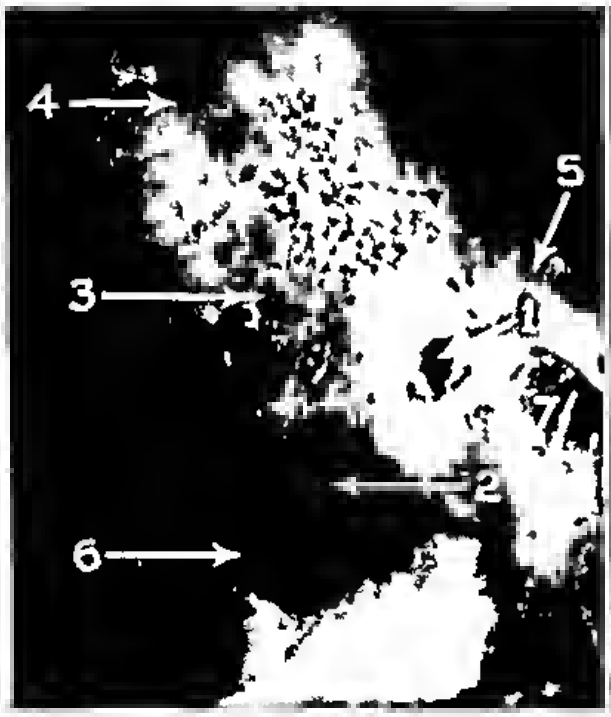


PLATE 102
Normal Mastoid Cells (1) Internal and external acoustic meatus (2) Mastoid process (3) Mastoid cells pneumaticised (4) Sigmoid sinus (5) Tegmen (6) Transverse sinus (7) Condyloid process of jaw

PLATE 103
Infected Mastoid with Destruction of Cells.

In examining a film of the antero-posterior view of the spine, the normal shows the spines of the vertebrae lying in a straight line in the centres of the shadows of the vertebral bodies

A gradual curve of the straight line indicates scoliosis faulty positioning of the patient during radiography must, of course be eliminated

RADIOGRAPHIC DISTORTION OF THE SPINE

In radiography of the spine, the horizontal axis of the vertebral bodies should be projected at right angles to the plane of the film, the rays from the tube falling parallel to the horizontal axis of the vertebrae

Because of the necessary relative nearness of the X ray tube (usually 25 inches) in radiography of the dorsal and lumbar vertebrae, the bodies and intervertebral

spaces in the central area of the film will alone appear in their true relations Those at the top and bottom of a 15 x 12 inch film will be projected by the obliquity of the rays to the film, with apparent widening of the shadow of the body by projection of the superior and inferior surfaces of the bodies into the intervertebral spaces producing an apparent narrowing of those spaces Where narrowing of the inter vertebral spaces is to be detected only the area covered by three or four vertebrae at the central area of the film can be utilised or the film to-tube distance should be increased to four feet to prevent distortion

In the spine, whenever possible antero posterior and lateral views should always be taken

PLATE 104

Eighth Nerve Tumour on left side causing widening of internal acoustic meatus and erosion of tip of petrous part of temporal bone (1) Normal petrous bone right (2) Tip of petrous bone eroded (3) Enlarged internal acoustic meatus

In the cervical region the following should be identified (Plates 113 and 114) —

(1) *Atlas*
(2) Axis and odontoid process in the antero posterior view as seen through the open mouth
(3) Bodies of other cervical vertebrae
(4) Transverse processes
(5) Intervertebral articulations
(6) Spines of vertebrae

The intervertebral disc space can be seen in the lateral view of the cervical spine but not in the antero-posterior view in all cases because of the tilt of the bodies The anterior part of the body of the first cervical vertebra in the lateral view is seen to lie in front of the second body and must not be mistaken for a dislocation

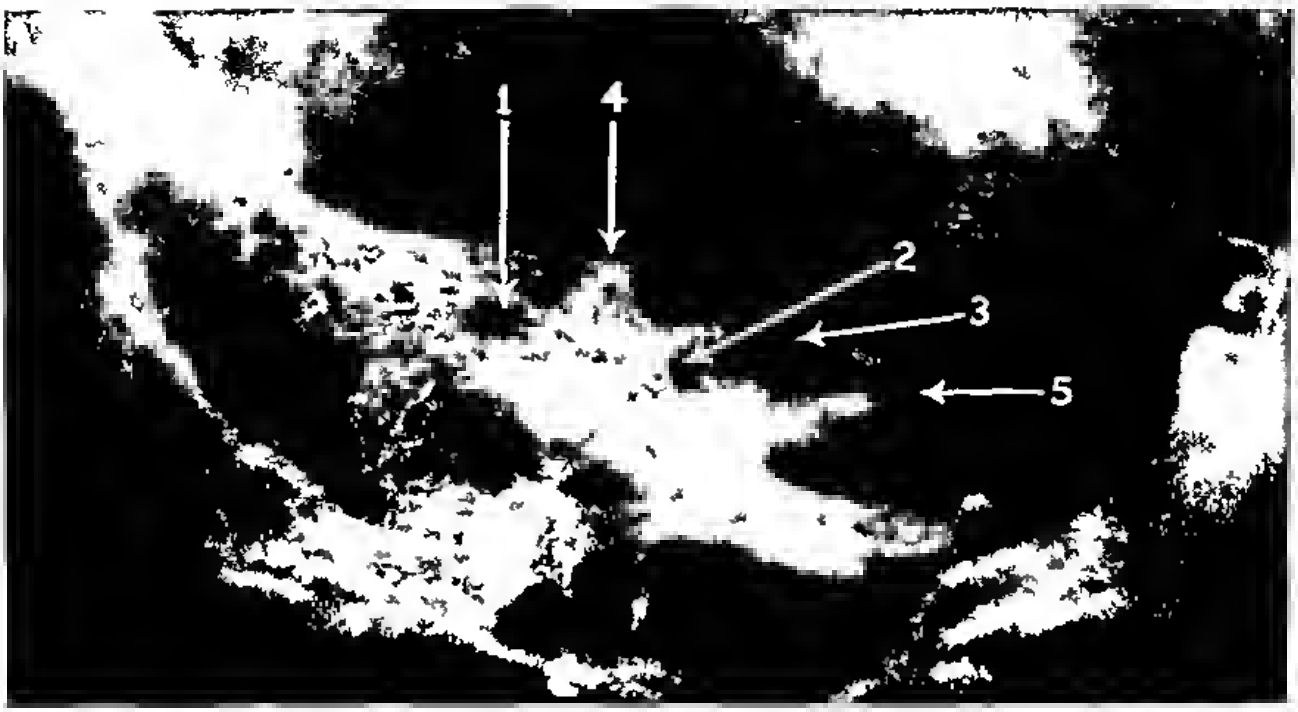


PLATE 105

Normal Petrous Part of Temporal Bone Stenver Projection

(1) Labyrinth
(2) Internal acoustic meatus
(3) Canal of facial nerve
(4) Arcuate eminence
(5) Tip of petrous bone

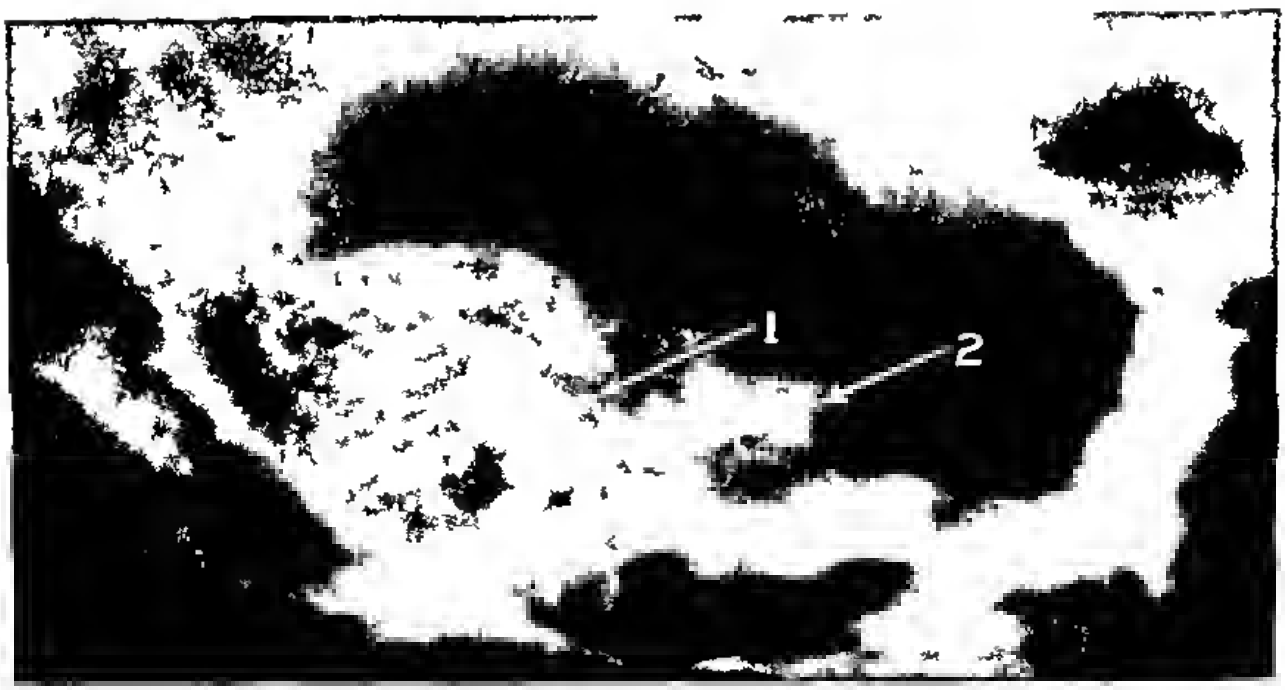
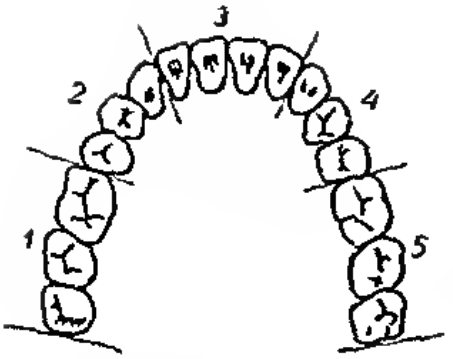


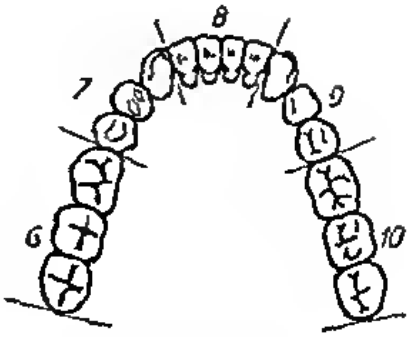
PLATE 106

Tumour of Eighth Nerve Eroding Tip of Petrous Part of Temporal Bone and Internal Acoustic Meatus (Compare with 105)

(1) Enlarged internal acoustic meatus.
(2) Blunting of tip or apex of petrous part of temporal bone



Upper Jaw



Lower Jaw

1 Left Molars
2 Left Premolars and Canines
3 Incisors
4 Right Premolars and Canines
5 Right Molars

6 Left Molars
7 Left Premolars and Canines
8 Incisors
9 Right Premolars and Canines
10 Right Molars

PLATE 107

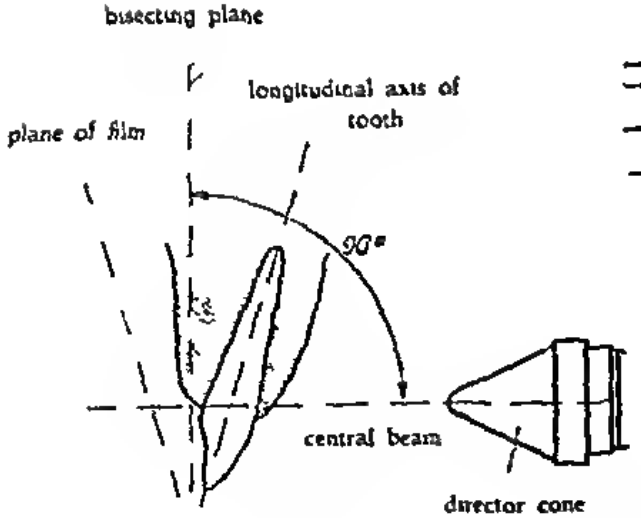


PLATE 108

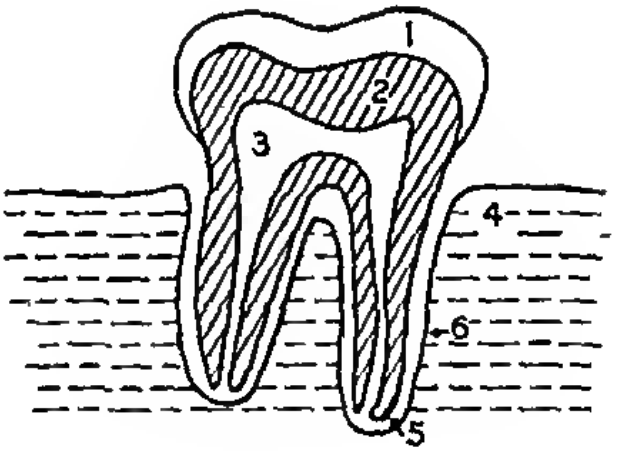


PLATE 109

Diagram of parts of a tooth (1) Enamel (2) Dentine (3) Pulp cavity (4) Cancellous structure of alveolus. (5) Periodontal space (6) Pericementum

PLATE 110
Pyorrhoea Note the pyorrhoeal destruction of the alveolar margin (1) and the tartar deposits (2)

PLATE 111
Apical Abscess (1) at Root of Tooth

PLATE 112
Dentigerous Cyst The tooth lies in a cavity indicated by arrow

PLATE 113
1st 2nd and 3rd Cervical Vertebrae antero posterior view radiographed through open mouth (1) Atlas (2) Transverse process of atlas (3) Axis (4) Odontoid process of axis (5) Atlanto-occipital joint. (6) Atlanto axis joint (7) Base of skull

In the thoracic region (Plate 115) —

(1) Bodies of the vertebrae
(2) Intervertebral spaces
(3) Transverse processes and rib articulation
(4) Spines of vertebrae

The transverse processes of the upper thoracic vertebrae point always slightly upwards and outwards Those of the lower thoracic and lumbar vertebrae point outwards and horizontally The upper four thoracic vertebrae appear less dense than the lower, because they are not covered by the shadow of the heart and great vessels

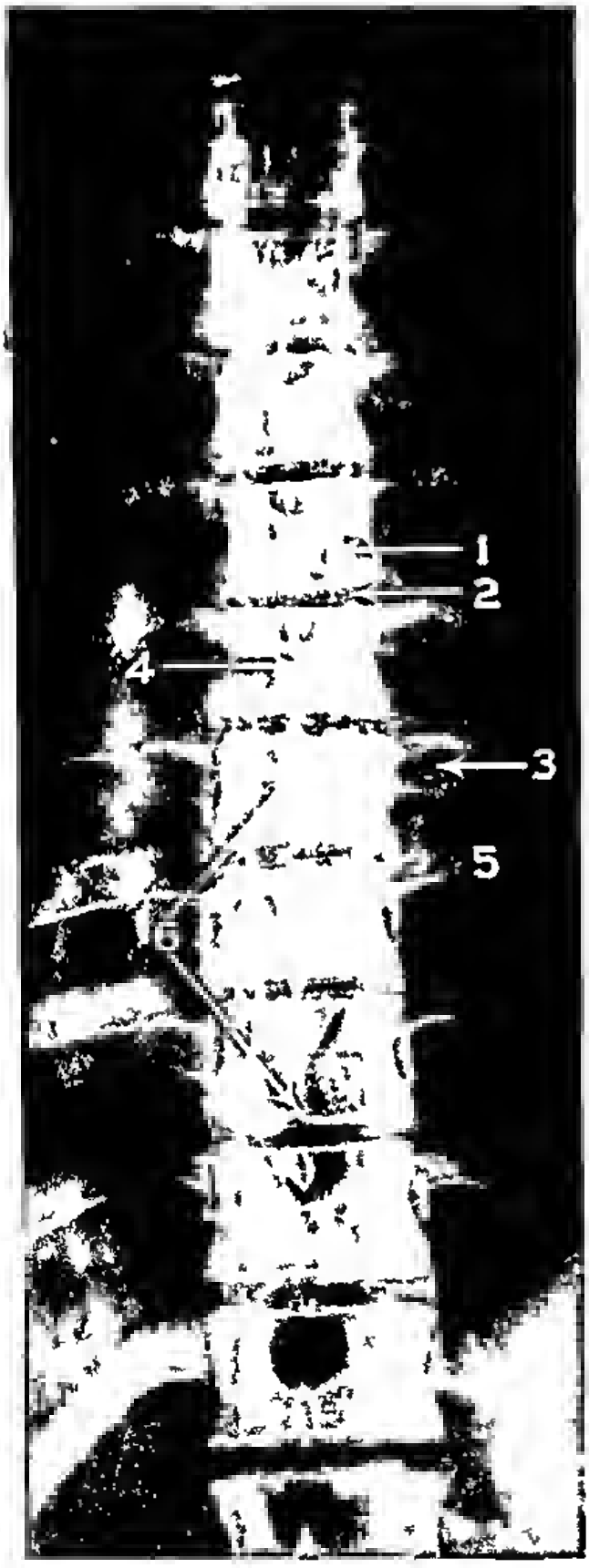
PLATE 114
Lateral view of Normal Cervical Vertebra Note the atlas appears to be in front of the axis

In the lumbar region (Plates 116 and 117) —

(1) Bodies of the vertebrae
(2) Intervertebral spaces
(3) Transverse processes
(4) Spines of vertebrae

A frequent abnormality is —

(*a*) extra long transverse processes of first and second lumbar vertebrae with or without short ribs,
(*b*) detached transverse processes on one or both sides They are evenly rounded as distinguished from fractures of the transverse process and show a definite articulation
(*c*) sacralisation of the last lumbar vertebra



DEVELOPMENT OF SPINE

Because of the numerous centres of ossification in the vertebrae there are a great variety of abnormalities which persist to adult life These are often only discovered accidentally or when osteo arthritis from strain caused by the abnormality occurs

The most common abnormalities are

(*a*) Spina bifida is the absence or failure of union of the spinous process It occurs often in the fifth lumbar vertebra and here is usually without significance but is even more commonly found affecting the first sacral segment (Plate 118)

(*b*) Extra ribs and fusion of ribs

(*c*) Extra bodies fusion of bodies half bodies

(*d*) Variations at the lumbo-sacral junction

In the last section these vary from complete fusion of the fifth lumbar vertebra to the sacrum to spina bifida of all the lumbar and sacral vertebrae

Wide variations in the angle of the lumbar spine to the sacrum occur but are only of importance when they cause spondylolisthesis

Fusion between atlas and axis occurs but rarely

The formation of epiphyseal plates seen on the superior and inferior surface of the anterior part of the body of the vertebrae is often recognisable between the tenth and twenty fourth years (Plates 119 to 121)

PLATE 115

Normal Dorsal Vertebra Antero-posterior view (1) Body of vertebra (2) Intervertebral space (3) Transverse process of vertebral body (4) Spinous process (5) Rib Note that the intervertebral spaces tend to become wider in the lower vertebrae also the bodies are slightly larger In the normal all the spinous processes lie in the same straight line (6) The spinous processes are often seen in the intervertebral spaces or through the upper part of the bodies of the next lower vertebra

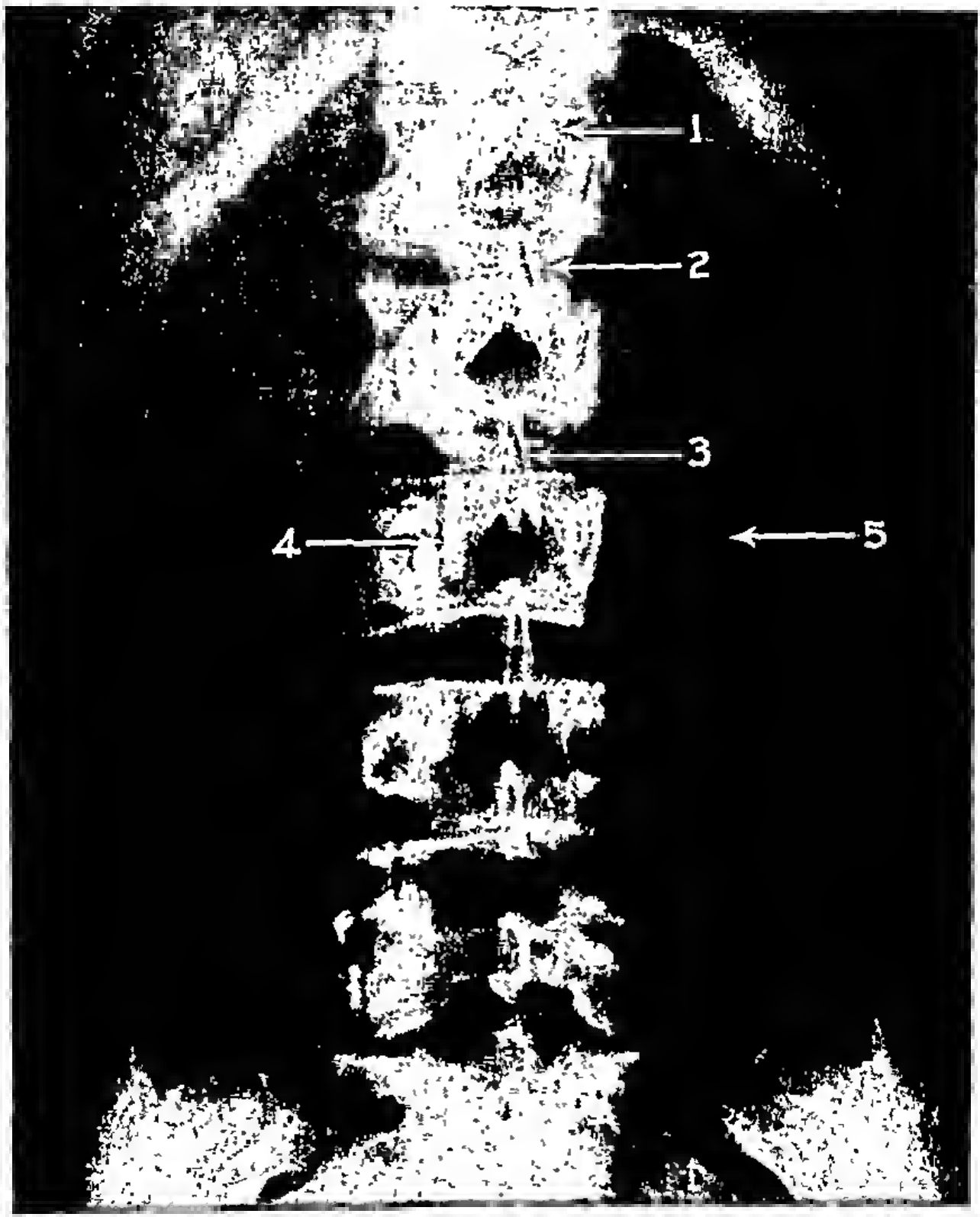


PLATE 116.

Normal Lumbar Spine (A.-P. view.) (1) Body of vertebra. (2) Intervertebral space. (3) Spinous process. (4) Articular process. (5) Transverse process.

PLATE 117.

Normal Lumbar Spine. (Lateral view).

(1) Body of Vertebra.
(2) Intervertebral space.
(3) Spinous process.
(4) Rib.
(5) Pedicle of vertebra.
(6) Crest of Ilium.

The anterior aspect of the bodies of the vertebra in young adults may show a well-marked canal for vessels (Plates 119 to 121)

DISEASES OF THE SPINE

Traumatic changes. Both lateral and antero posterior views should always be taken

(*a*) *Dislocations of the vertebrae* (Plate 122) usually take place in the antero posterior plane and are most easily recognised in the lateral view The anterior surfaces of the bodies in the normal form a regular line which is interrupted when dislocation and fracture take place

(*b*) *Fractures of the body or transverse processes* (Plate 123) The fracture deformity

PLATE 118.
Spina Bifida Antero posterior view of cervical vertebrae The line of the failure of fusion is marked with arrows The vertebrae above and below show normal fusion

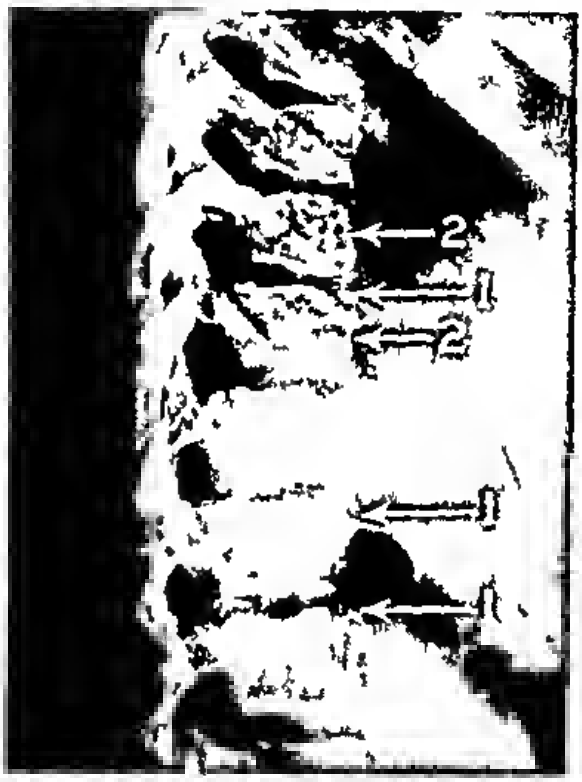


PLATE 119
Dorsal Spine in a Child (1) Epiphyseal plates. (2) Nutrient canals

of the body is typically wedge shaped, the line of fracture through the body may be undetectable In fracture of the body, the wedge usually points forwards and the body shows increased density towards the thin edge of the wedge, whereas, in the congenital wedge shaped vertebra, *the body density is not increased* Fracture of the transverse process must be distinguished from the appearance of a separate epiphysis which has remained unfused, in which the outline of the bone at the supposed fracture line has a soft, rounded appearance and not the hard, sharp, serrated appearance of a fracture

(*c*) Fracture of the odontoid process of the axis usually shows the process with the atlas displaced backwards The anterior part of the atlas then lies in the same line with the axis or behind it The ring of the atlas may also be fractured (Plate 124)

(*d*) *Kümmel's disease—Osteochondritis of the spine*—is late evidence of fracture of the body of a vertebra In an incomplete vertebral fracture of the body, there may be little deformity and this may escape detection at the time of injury, later, collapse of the vertebra takes place with wedging forwards and irregularity of the internal structure This is known as post-traumatic Kümmel's disease of the vertebral bone (see Osteochondritis)

Inflammatory diseases.

Osteoarthritis This shows itself by the formation of outgrowth of bone round the articular surfaces There is usually no bone atrophy (*Plate 125*).

Spondylitis This begins with the appearance of an ordinary osteoarthritis, but rapidly progresses to ankylosis between the bodies and synostosis

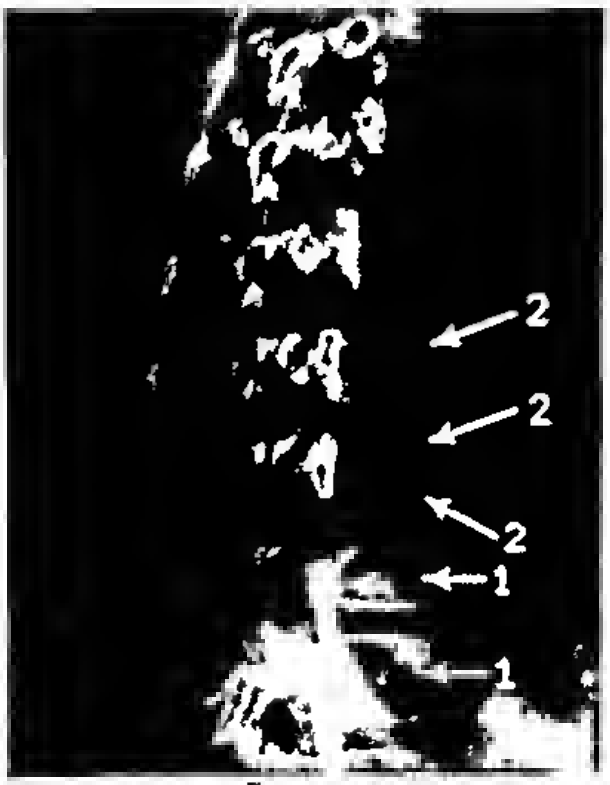


PLATE 120
Lateral view of Dorsal Vertebra in Child Note the canals for vessels (1) and vertebral plate (2) which have not yet become joined to the bodies

Osteomyelitis The changes are difficult to detect in the early stages, and do not differ from those seen in typical osteomyelitis (See Osteomyelitis, page 33)

Typhoid spine In the early stages the appearance is similar to that of osteomyelitis In the later stages, ankylosis and synostosis of the affected vertebrae occur often the whole dorsal or lumbar spine is ankylosed

Tuberculosis of the spine (Plate 126) Radiographic changes are —

(*a*) Narrowing or loss of the intervertebral space with approximation of the vertebral bodies is one of the earliest changes

(*b*) Marked atrophy of one or two adjoining bodies, with loss of detail in bone texture, and local areas of bone destruction

Progress
- (*a*) Collapse of the body of the vertebra and sclerosis
- (*b*) Forward wedging
- (*c*) Abscess formation obliterating the outline of the vertebrae This is not a constant feature

Healing
- (*a*) Without evidence of change, a complete reparative process but rarely occurs
- (*b*) With the appearance of localised osteoarthritic changes, wedging and ankylosis

THE APPEARANCE OF PRIMARY SARCOMA OF A VERTEBRA
(Plate 127)

Changes —
- (*a*) Atrophy of a single body
- (*b*) Irregular destruction of the body
- (*c*) Irregular osteoplastic formation (very rare)
- (*d*) Collapse of the atrophied body
- (*e*) The intervertebral spaces are not usually affected

The presence of any other primary neoplasm must be excluded

It is distinguished from tuberculosis of the spine, in which the intervertebral space is affected early

Secondary neoplasm in the vertebra (Plate 128)

The appearance is similar to that of secondary carcinomatous invasion of any other bones (see page 61)

The atrophic type of change is the most common, collapse of the body is a late change and takes place terminally

The osteoplastic type of change is rare and is seen usually associated with

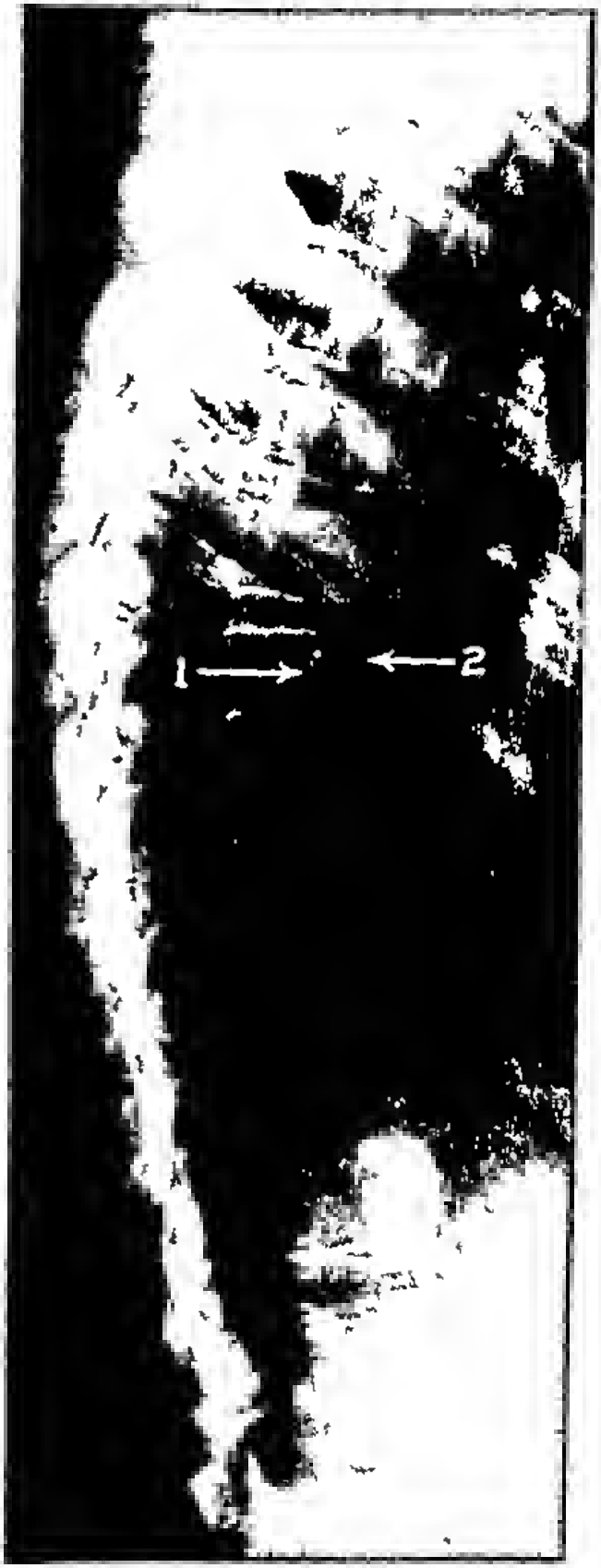


PLATE 121
Lateral view of Dorsal Vertebrae in a Child Note the slight irregularity of the bodies (1) which is not pathological and the canals for vessels (2) which disappear in adult life

PLATE 122
Lateral view of Cervical Spine showing forward dislocation of cervical 6 on 7

PLATE 123
Lateral view of Fracture of Body of Vertebra irregularity of anterior border and wedging indicated by arrow

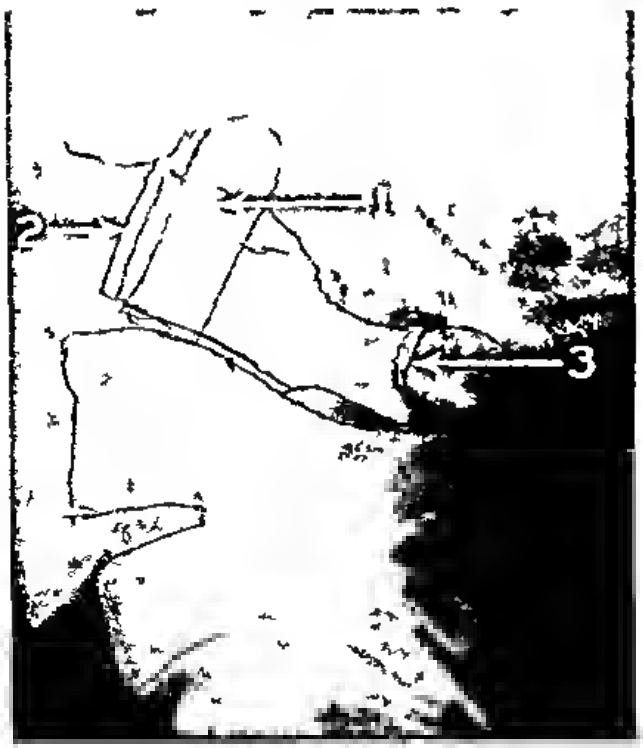


PLATE 124
Fractured Odontoid (1) with backwards dislocation of atlas (2) on axis which is also fractured (3)

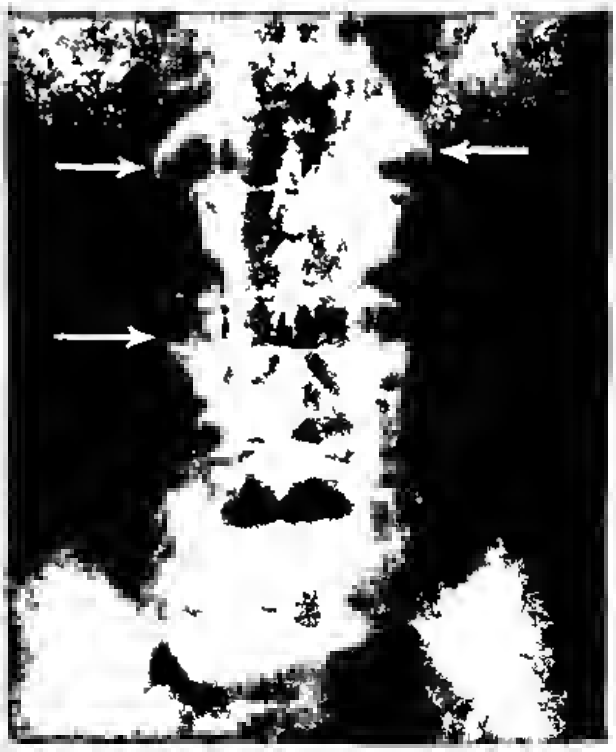


PLATE 125
Osteoarthritis of Spine (Spondylitis) Osteophytes indicated by arrows

carcinoma of the prostate It may change into the osteolytic (Plate 64)

Metabolic disease Paget s disease in the spine is similar to that seen in other bones (see Paget s disease page 42) It is always associated with osteoarthritis of the spine

Erosion of vertebra from pressure is seen in the lateral view (Plate 129) It may be caused by —

(1) Aneurysm (common)
(2) Hodgkin s disease (rare)

The anterior surfaces of the bodies are excavated the intervertebral discs and superior and inferior surfaces are not usually affected

Spondylolisthesis (Plate 130) Spondylolisthesis should always be demonstrated

PLATE 126
Tuberculosis of Spine Loss of intervertebral space destruction of opposing surfaces of vertebra with some sclerosis.

by a lateral view showing the relation of the body of the fifth lumbar vertebra to the first sacral segment

In the normal a smooth curve can be drawn along the anterior surfaces of the vertebra and the sacrum in spondylolisthesis this line becomes humped by the anterior surface of the fifth lumbar vertebra The fifth lumbar vertebra is displaced forward on the sacrum to a degree varying with the severity of the lesion and associated in the more severe types with defect or fracture of the neural arch of the fifth lumbar vertebra

The intervertebral discs are not opaque to X rays and calcification only occurs in them in disease Plates show an example of calcification of the nucleus pulposus following infective chondro-neuritis (Plate 131)

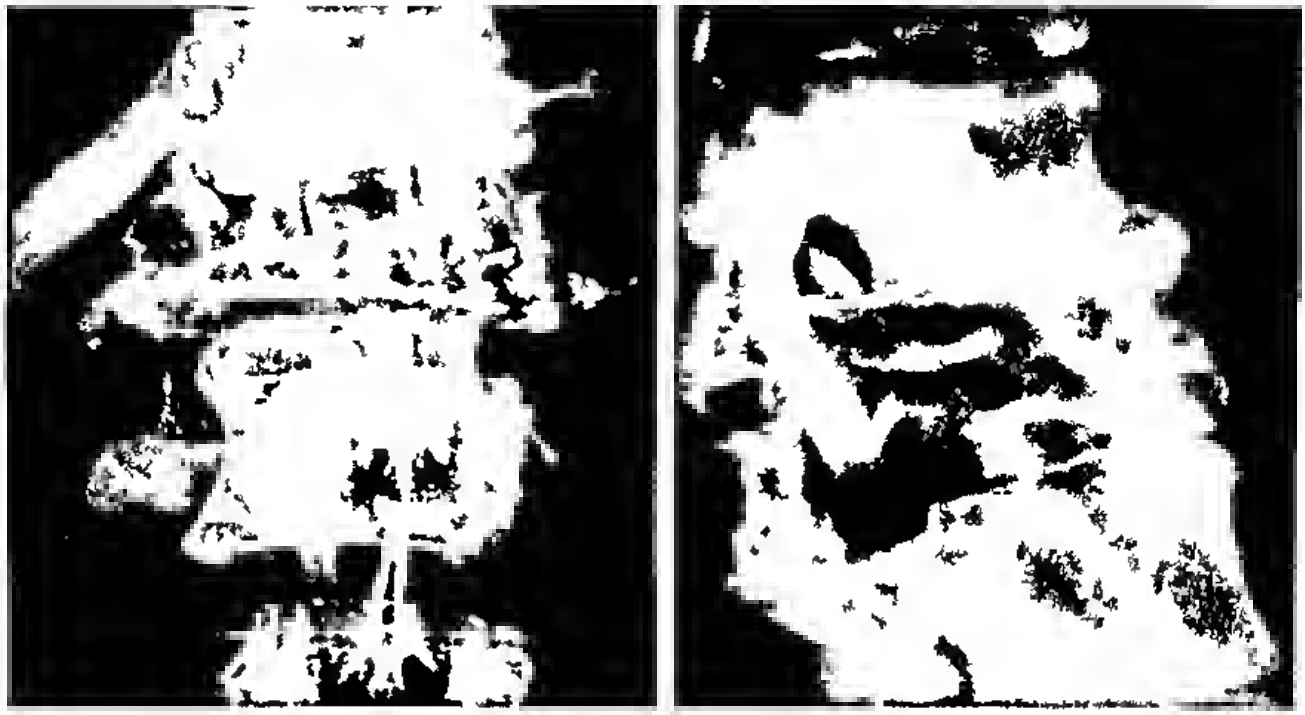


PLATE 127

Sarcoma of Body of 1st Lumbar Vertebra. There is collapse of the body The disease is isolated to the single vertebral body The diagnosis (confirmed by biopsy) can only be arrived at radiographically by eliminating any other primary neoplasm

PLATE 128

Osteoplastic Carcinoma (lateral view) of Vertebra with collapse The bodies above and below are not involved

PLATE 129
Pressure Erosion of bodies of 11 and 12 Dorsal Vertebrae by Aneurysm of Aorta indicated by arrows The intervertebral spaces and the rest of the vertebral bodies are not affected

PLATE 130
Spondylolisthesis (1) 5th lumbar vertebra (2) Sacrum

PLATE 131
Calcification of Nucleus Pulposus A P and Lat views of calcification in intervertebral disc.

RIBS

The ribs forming the bony framework of the chest lie in a difficult plane for satisfactory radiography

The cartilaginous parts between the sternum and rib-ends are non opaque to X-rays when calcification takes place in them, it is usually more dense than the bone and appears as irregular beading on the rib ends along the edges of the cartilage Care must be taken not to confuse calcification in the rib cartilages with gallstones, or opacities in the lung

FRACTURE OF RIBS

This can only be demonstrated as a discontinuity in the bone It must not be confused with the lip on the lower surface of the shaft of the rib about its centre,

PLATE 132
Sarcoma of Rib (1) Osteolysis of rib (2) Sarcoma mass extending into lung

which may simulate a fracture, but the line of fracture is absent Lung markings and arterial grooves must be distinguished from fracture lines by their softer outline

MULTIPLE MYELOMATOSIS

The shafts of the ribs are studded with clear-cut holes associated with similar changes in the shafts of other bones and skull A similar change is seen in some cases of leukaemias in the terminal stages

SARCOMA

(Plate 132)

Sarcoma of a rib usually shows an area of destruction of the rib associated with

a rounded opacity of the peripheral lung field. The change in the rib may be obscured by an effusion into the chest.

CHONDROMA

Chondroma of a rib is smooth in outline and not associated with change in the lung. The tumour always shows the diagnostic "chondroma spots."

CHANGES IN RIBS ASSOCIATED WITH COAPTION OF THE AORTA

The ribs show, in their posterior third, small defined areas of erosion affecting the margin from pressure of the dilated intercostal vessels.

OTHER DISEASES OF THE RIBS

Other diseases of the ribs do not differ from those seen in other bones, though their satisfactory radiography is often difficult.

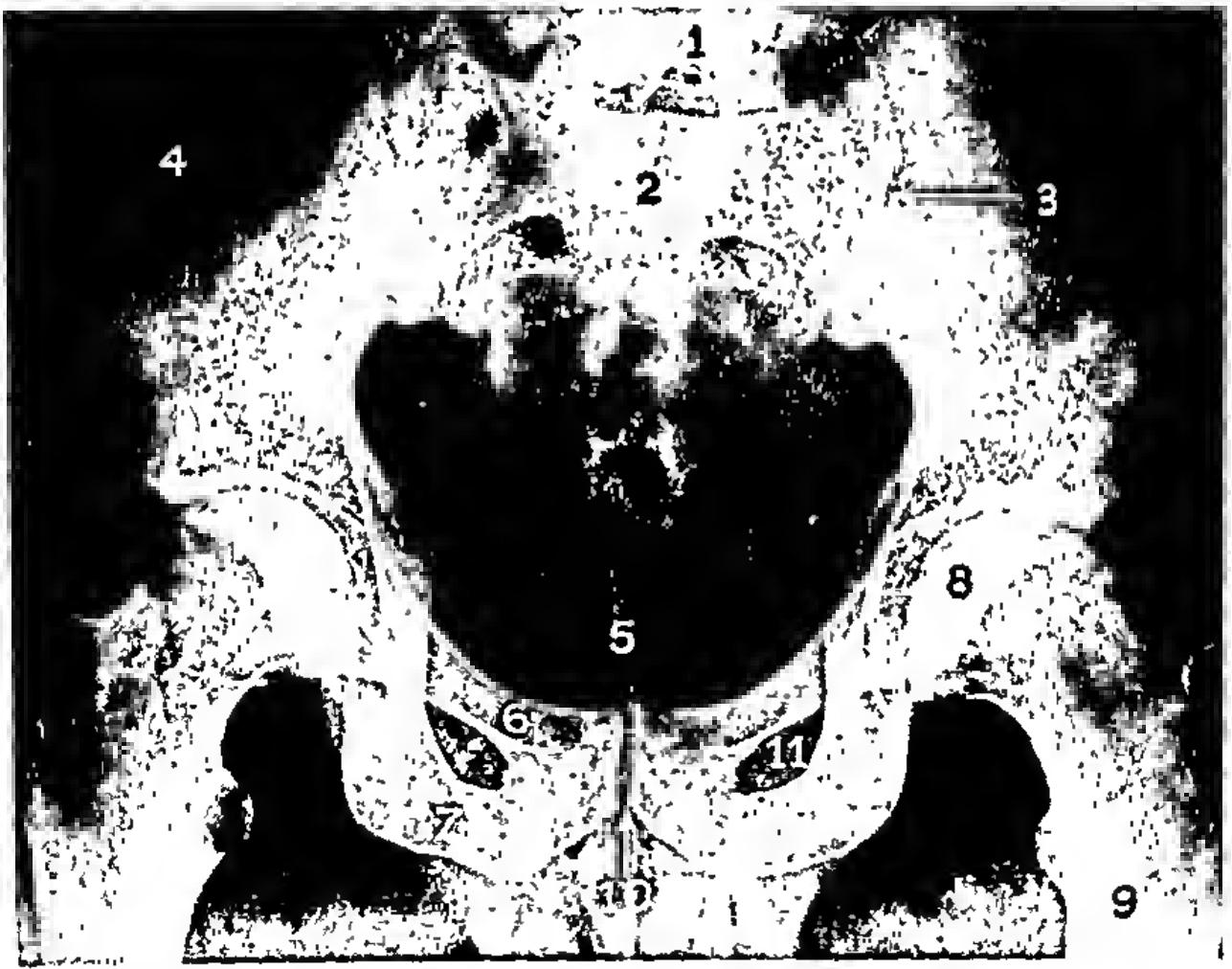


PLATE 133.

Adult Pelvis.

(1) Fifth lumbar vertebra.
(2) Sacral bone.
(3) Sacroiliac joint.
(4) Ilium.
(5) Coccyx.
(6) Pubic bone.
(7) Ischii.
(8) Head of femur.
(9) Shaft of femur.
(10) Symphysis pubis.
(11) *Obturator foramen.*

THE PELVIS

THE ADULT PELVIS

The adult pelvis, because of the different planes in which the bones lie, presents certain radiographic difficulties which can best be investigated by stereoscopic examination Care must be taken not to interpret gas, bowel contents, or calcified gland shadows as changes in the bones The true relations of such shadows can be seen stereoscopically

THE PELVIS IN THE CHILD

(Plate 135)

At birth, the ilium, pubis and ischium are already partly calcified Cartilage forms the acetabulum and the junctions between the ilium, pubis and ischium Union takes place about the fifth year Other epiphyses appear at the crest of the ilium, the symphysis pubis, anterior inferior iliac spine and ischial tuberosity at the fifteenth year and unite about the twenty first year

DEVELOPMENTAL ABNORMALITIES

The commonest of these is open sacral segments, and it is of no significance in most cases

FRACTURES

These are of any type and very diverse, depending on the type of trauma They are often very difficult to detect without stereoscopic radiographs

INFLAMMATORY DISEASE

For chronic osteomyelitis, see page 34

TUBERCULOSIS

This is usually seen, when developed, as an area of bone atrophy close to the acetabulum, with a well marked clear area of tuberculous debris surrounded by a ring of sclerosis A similar change may occur at the sacroiliac joints

NEOPLASMS OF THE PELVIS

(1) **Exostoses**, single or multiple, are of importance only if likely to cause obstruction to labour (see page 55) or movements of the femora

(2) **Sarcoma** (see page 60)

(3) **Secondary carcinomatosis** (see page 61)

(*a*) In the osteolytic type there is irregular bone destruction

(*b*) In the osteoplastic type, which resembles Paget s type of osteosclerosis, the pubis and acetabular regions are most often affected Diagnosis is made from Paget's disease by an X ray examination of the skull, femora and other bones for the typical changes of Paget's disease

(*c*) Sometimes the disease is first recognised when both the osteolytic and osteoplastic changes are present together when the radiograph is diagnostic.

METABOLIC DISEASES

(1) **Paget s disease** shows (see page 42) —

(*a*) very pronounced osteosclerosis ,

(*b*) a general loss of bone detail with the trabeculations showing a " cotton wool " appearance

(*c*) an associated osteoarthritis

(2) **Osteitis fibrosa cystica** (see page 46)

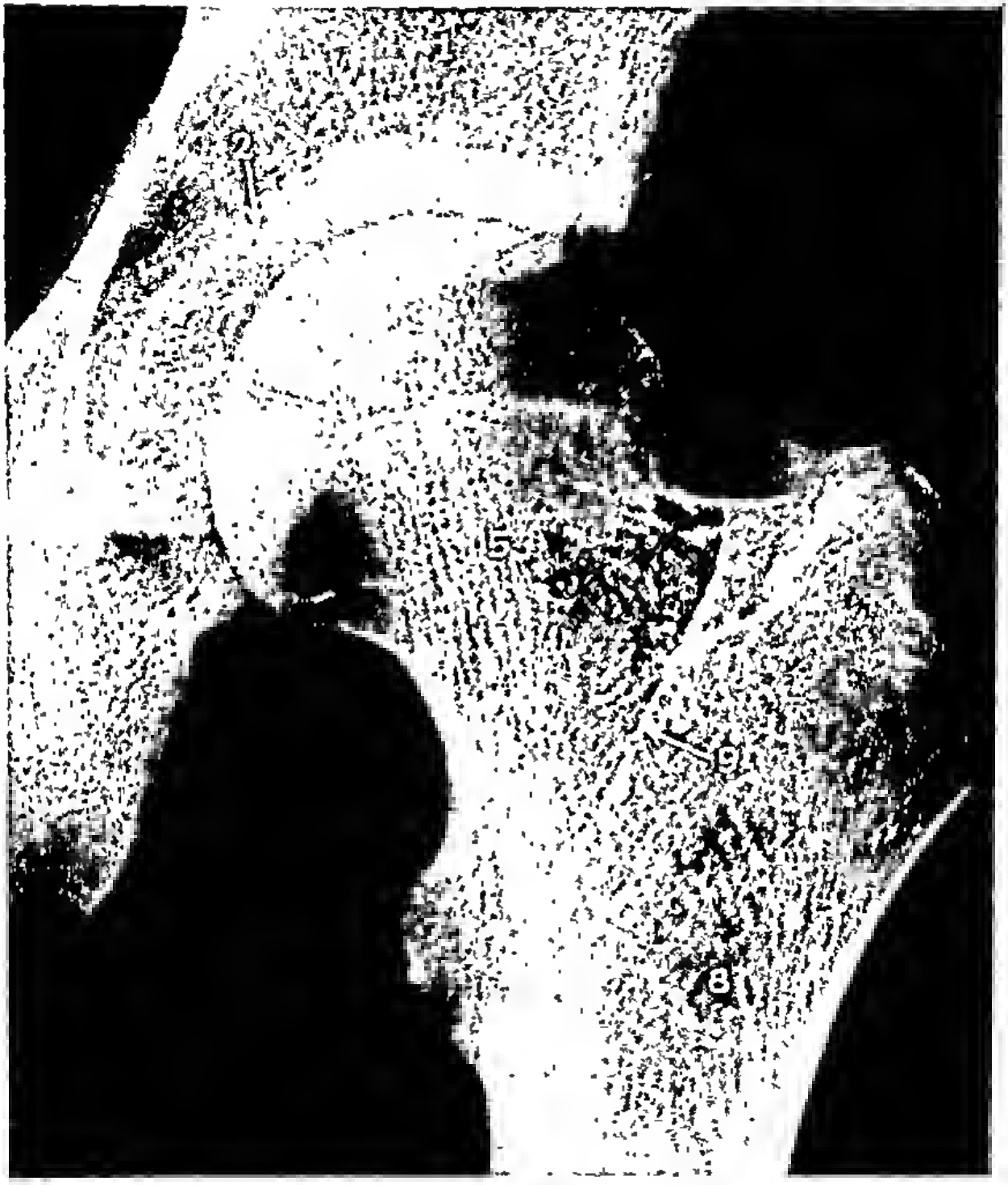


PLATE 134.

Adult Hip.

(1) Ilium.
(2) Acetabular margin.
(3) Head of femur.
(4) Fovea capitis.
(5) Neck of femur.
(6) Greater trochanter.
(7) Lesser trochanter.
(8) Femur.
(9) Intertrochanteric line.

THE SACROILIAC JOINT

The sacroiliac joint can only be satisfactorily examined in stereoscopic views because of the obliquity of the joint and the difficulty of obtaining a single radiograph which will show the joint space

CHANGES IN THE JOINT

(1) Widening is seen in the joint spaces in the pregnant woman before delivery and is a physiological change

(2) Narrowing associated with sclerosis of bone is seen in infective disease of the joint Though often indicating a tuberculous lesion it may, however, be part of a simple infective arthritis

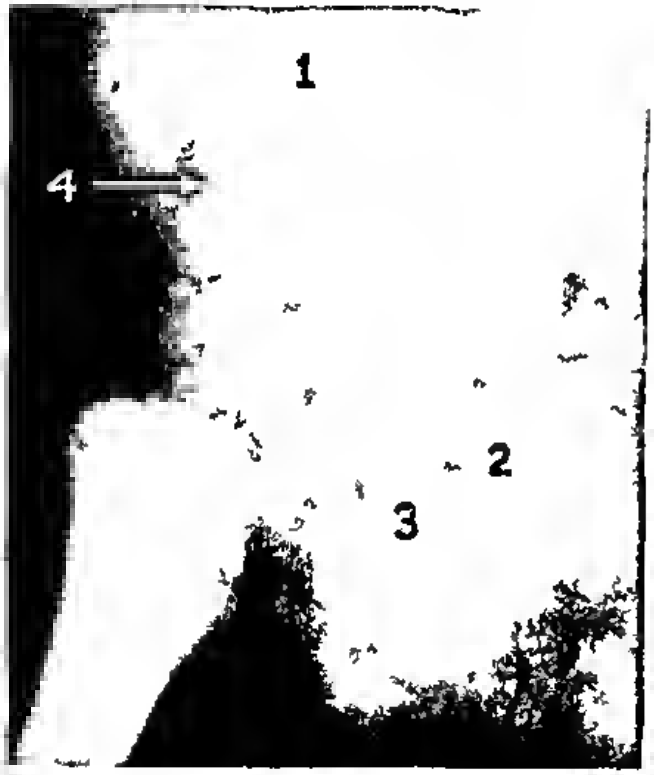


PLATE 135

Hip of Child at Birth
(1) Ilium
(2) Superior ramus of pubis
(3) Inferior ramus of pubis
(4) Right angle ledge

PLATE 136

Hip of Child aged Seven Years
(1) Head of femur
(2) Greater trochanter
(3) Il um and os pubis not yet united

(3) Narrowing associated with lipping specially marked at the lower end of the sacroiliac joint indicates osteoarthritis The lumbar spine usually shows similar changes

THE HIP

It is important that the hip should be X rayed in the standard position i e so that in an antero posterior view with the patient lying on his back his toes must point directly upwards—otherwise the projection of the neck of the femur will be distorted simulating coxa vara or plana In the normal position the angle of the head of the femur to the shaft is 120°–130° (Plate 134)

SHENTON'S LINE

This is an imaginary line formed by the line of the medial aspect of the neck of the femur joining the upper margin of the obturator foramen In the normal it forms a smooth arc which is broken by any abnormal variation in the position of the acetabulum or head and neck of the femur

AREAS IN THE UPPER END OF THE FEMUR SIMULATING CYSTS

(1) Where the base of the greater trochanter joins the upper end of the femur on its postero-lateral surface it may by its shape simulate a cyst

(2) The pronounced digital fossa at the base of the upper aspect of the femoral neck must not be mistaken for a small cyst

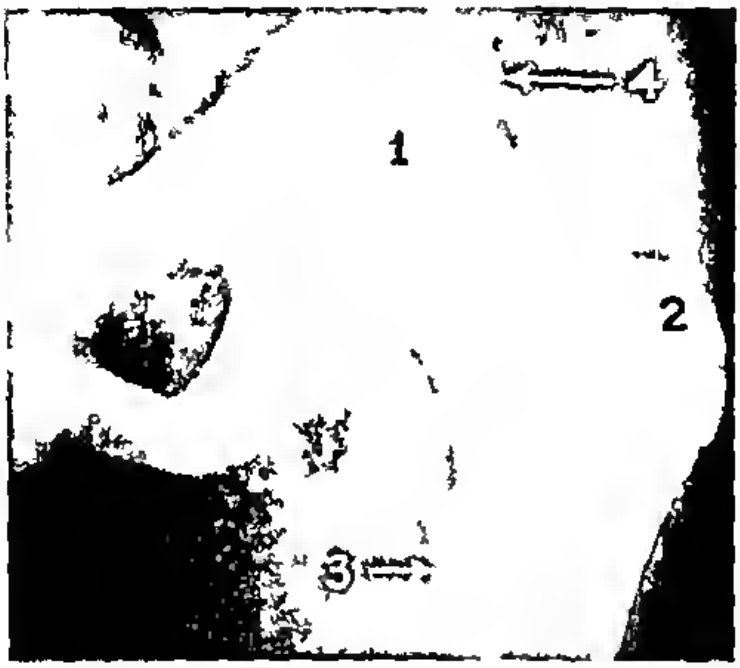


PLATE 137
Hip of Young Adult aged Eighteen Years
(1) Head of femur (2) greater trochanter (3) lesser trochanter (4) os acetabuli (extra ossicle) Note the ilium and pubis are united

The true position of these artefact cysts may be seen on stereoscopic examination or by taking other films with extreme internal and external rotation of the femur

EPIPHYSIS OF THE HIP

The hip at birth (Plate 135) The head of the femur does not appear until between the first and second year Whether or not the hip is normal at birth can only be verified by the normal appearance of Shenton s Line and of the right angle formed by the edge of the ilium (see Congenital Dislocation of the hip)

Bone	*Appears*	*Unites*
Head	1 2 years	18 19 years
Greater trochanter	3 4 years	18 19 years
Lesser trochanter	13 years	16-17 years

(See Plates 135 136 137)

The os acetabuli (Plate 137) is formed as part of the synostosis of the acetabulum, it lies at the external edge of the acetabulum and may remain unfused throughout life, but often unites with the acetabulum at the fifteenth year It must not be mistaken for a true loose body or fracture

DISLOCATION OF THE HIP

This is recognised by absence of the head of the femur from the acetabulum It may be difficult to see in a posterior dislocation, when it should be confirmed by stereoscopic radiographs showing the true relation of the head

In all cases of dislocation, Shenton's Line is not seen in normal continuity

PLATE 138
Congenital Dislocation of Hips Note the absence of normal ledge of the acetabulum.

The commonest causes are —
(*a*) Traumatic
(*b*) Inflammatory
(*c*) Infective

Congenital dislocation (Plate 138) The diagnosis depends on recognition of
(1) The disturbance of Shenton's Line
(2) The absence of the rectangular ledge at the upper end of the acetabulum
(3) A poorly formed or absent acetabulum
(4) The femur is often displaced upwards

Coxa vara (Plate 139) In this deformity the angle of the head to the shaft of the femur is less than 125° The neck appears shortened

The causes of coxa vara are —

(1) Traumatic
(2) Localised osteochondritis (Perthe s disease)
(3) Slipping of the femoral head
(4) As part of a general disease
  (*a*) rickets
  (*b*) osteitis
  (*c*) achondroplasia
  (*d*) chondro-osteodystrophy

PLATE 139
Coxa Vara (Infantile) The neck which is bent from we ght bearing shows scleros s and disorganisa tion with decalcification at the metaphys s The small triangular isolated area of the neck ind cated by arrow is almost a constant feature

PLATE 140
Wandering Acetabulum The acetabulum is eroded in its upper part The femur is d splaced upwards There is disorganisation of the femoral head and sl orten ng of the neck The greater trochanter approaches nearer to the mid l ne

  (*e*) cretinism
  (*f*) Paget s disease
  (*g*) osteogenesis imperfecta
  (*h*) renal rickets
(5) As part of a localised disease
  (*a*) tuberculosis
  (*b*) syphilis
  (*c*) osteomyelitis

Coxa valga The angle of the head to the shaft of the femur is more than 125° The neck appears lengthened

The most common causes are —

(1) Trauma
(2) Rickets
(3) Septic osteitis
(4) Poliomyelitis
(5) Secondary to hypertrophic osteoarthritis

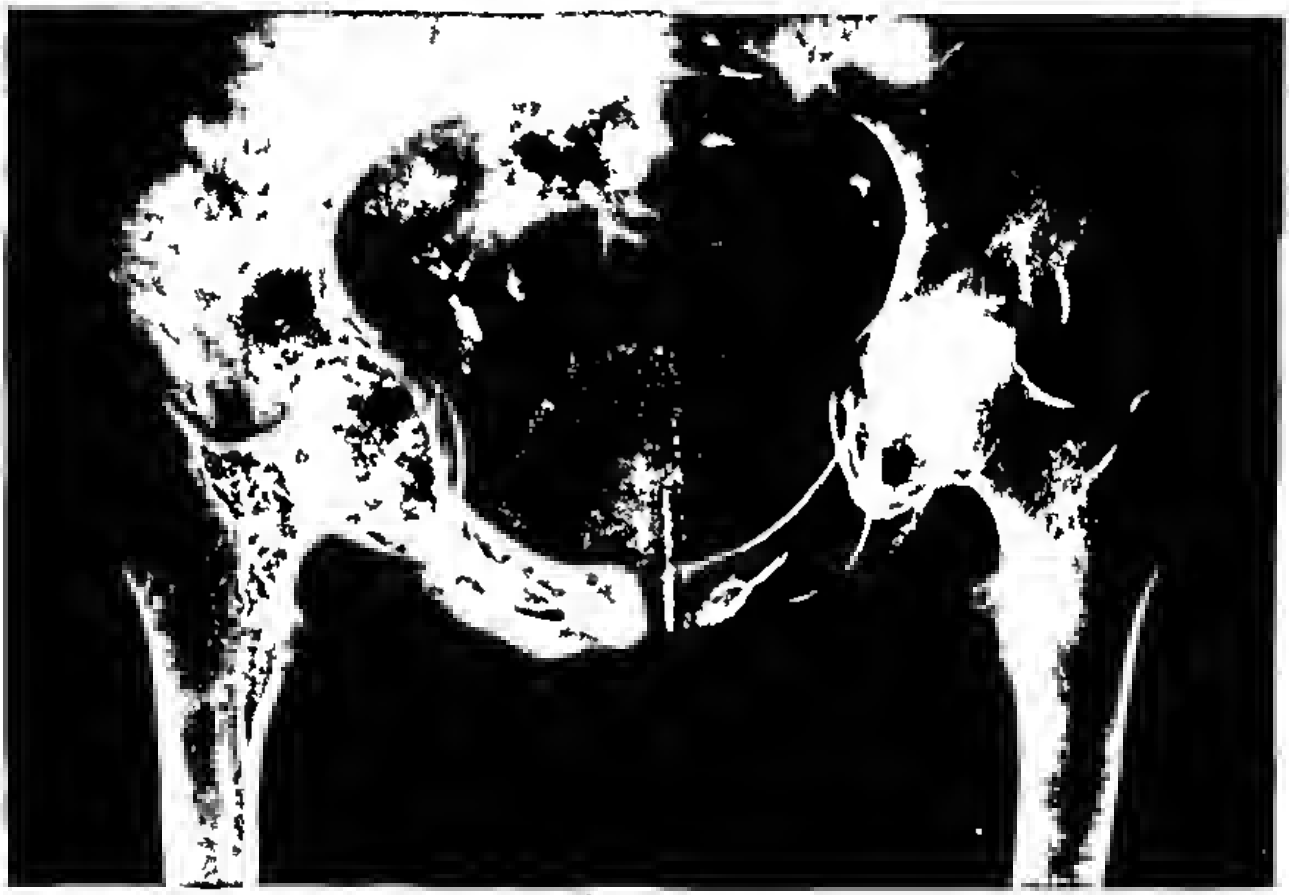


PLATE 141

Protrusio Acetabuli (sunken Acetabulum) The heads of the femora have sunk into the acetabula which protrude into the pelvic cavity

Wandering acetabulum (Plate 140) This is a deformity of the acetabulum The commonest causes are —

(1) Softening of the upper part of the acetabulum from disease
(2) Relaxation and destruction of ligaments of the hip joint

Radiographic changes are —

(1) Disturbance of Shenton s Line
(2) The head of the femur erodes into the ilium so that the acetabulum becomes enlarged upwards

Protrusio acetabuli (Plate 141) In this condition the heads of the femora sink into the acetabuli which are deeper than normal and protrude into the pelvis It is usually bilateral

PERTHE S DISEASE
(Plate 142)

A form of osteochondritis affecting the head and neck of the femur (see Osteochondritis page 51)

The characteristic changes are —

(1) The head shows irregular osteosclerosis and is fragmented
(2) Flattening and mushrooming of the head
(3) The joint space is not affected or may be widened It is never narrowed
(4) The neck often shows widening and areas of rarefaction
(5) There is no bone atrophy unless immobilisation has taken place.

PLATE 142
Perthe s Disease. Note the flattening of the femoral head and the widen ng of the neck The acetabulum itself shows no change

Order of bone changes —

1st stage The head or neck shows spotty areas of sclerosis which later coalesce
2nd stage. Widening of the epiphyseal line.
3rd stage Roughening of the outline of the head
4th stage Weight bearing deformity The head is flattened the neck of the femur becomes wider shorter and bent leading to (1) mushrooming of the head of the femur and (2) bending of the neck with little change in the head of the femur depending on whether the head or neck is most affected (Plate 143)

OSTEOARTHRITIS OF THE HIP

There are two general types —

(1) The hypertrophic type, involving the acetabulum the head is often dislocated upwards by the formation of bone in the lower part of the acetabulum

(2) The mushroom-head type The head which shows numerous osteophytes round its periarticular surface, is encapsulated by the lipping of the acetabulum (see Osteoarthritis page 66)

PLATE 143

Healed Perthe s Disease Showing coxa vara deformity The neck of the femur is shortened and the head flattened

CHARCOT S DISEASE OF THE HIP

Charcot s disease shows the following changes —

(1) Marked atrophy of the bone around the head of the acetabulum
(2) Erosion of the bones of the head of the femur and the acetabulum
(3) Dislocation of the head of the femur usually upwards
(4) Loose body formation

(See Neuropathic joint changes, page 69)

A Onset of disease The joint space is alone widened No other definite change

B Later stage active disease Rarefaction of the head neck and shaft of femur also of acetabulum The bones show ground glass type of atrophy

C. Later stage showing healing The joint space has become normal and the bones show normal density

PLATE 144
Showing Three Stages in Tuberculosis of the Hip Joint.

ANKYLOSIS OF THE HIP

The bone trabeculations must be traceable from the acetabular zone into the head of the femur

TUBERCULOUS INFECTION OF THE HIP (See Tuberculosis, page 37) (Plate 144)

The typical changes are —

(*a*) Atrophy of the acetabulum and head of the femur
(*b*) A clear area of destroyed bone with sclerosis around it, the tuberculous focus
(*c*) Some irregularity of the joint space
(*d*) Sometimes obliteration of the joint space

Healing may take place with

(*a*) Complete resolution without evidence of bone disease
(*b*) Absorption of the head of the femur
(*c*) Ankylosis between the head of the femur and the acetabulum

Tuberculosis must be differentiated from Perthe's disease, which does not show

(*a*) Atrophy of bone
(*b*) Acetabular changes
(*c*) Narrowing of the joint space

Plates 144 A B, C, show the onset, later active and healing stages of a typical tuberculous infection of the hip

THE SHAFT OF THE FEMUR

The posterior aspect of the shaft of the femur in the lateral view appears thicker than the anterior This is caused by the linea aspera and must not be mistaken for thickening of the cortex Above the condyles of the femur on its posterior aspect, there is an irregular ridge, the adductor tubercle, which is the origin of the gastrocnemius and plantaris muscles (plate 146)

THE KNEE

(Plates 145 and 146)

The knee should be X-rayed in the antero-posterior and lateral planes for examination Care must be taken that the central beam from the X ray tube shall pass through the centre of the joint space

EPIPHYSES ROUND THE JOINT (Plates 147 and 148)

Bone	*Appears at*	*Unites*
Lower femoral epiphysis	8 months, i u l	20 years
Upper tibial epiphysis	at birth	20 years
Tubercle of upper tibial epiphysis (not always separate)	12 years	21 years
Upper fibular epiphysis	3 years	21 years
Patella	3 years	

ACCESSORY BONES

The flabella, when present, lies medial and posterior in the tendon of gastrocnemius muscle It must not be mistaken for a loose body

The patella may be absent or developed in several separate segments (multipartite) which may remain unfused

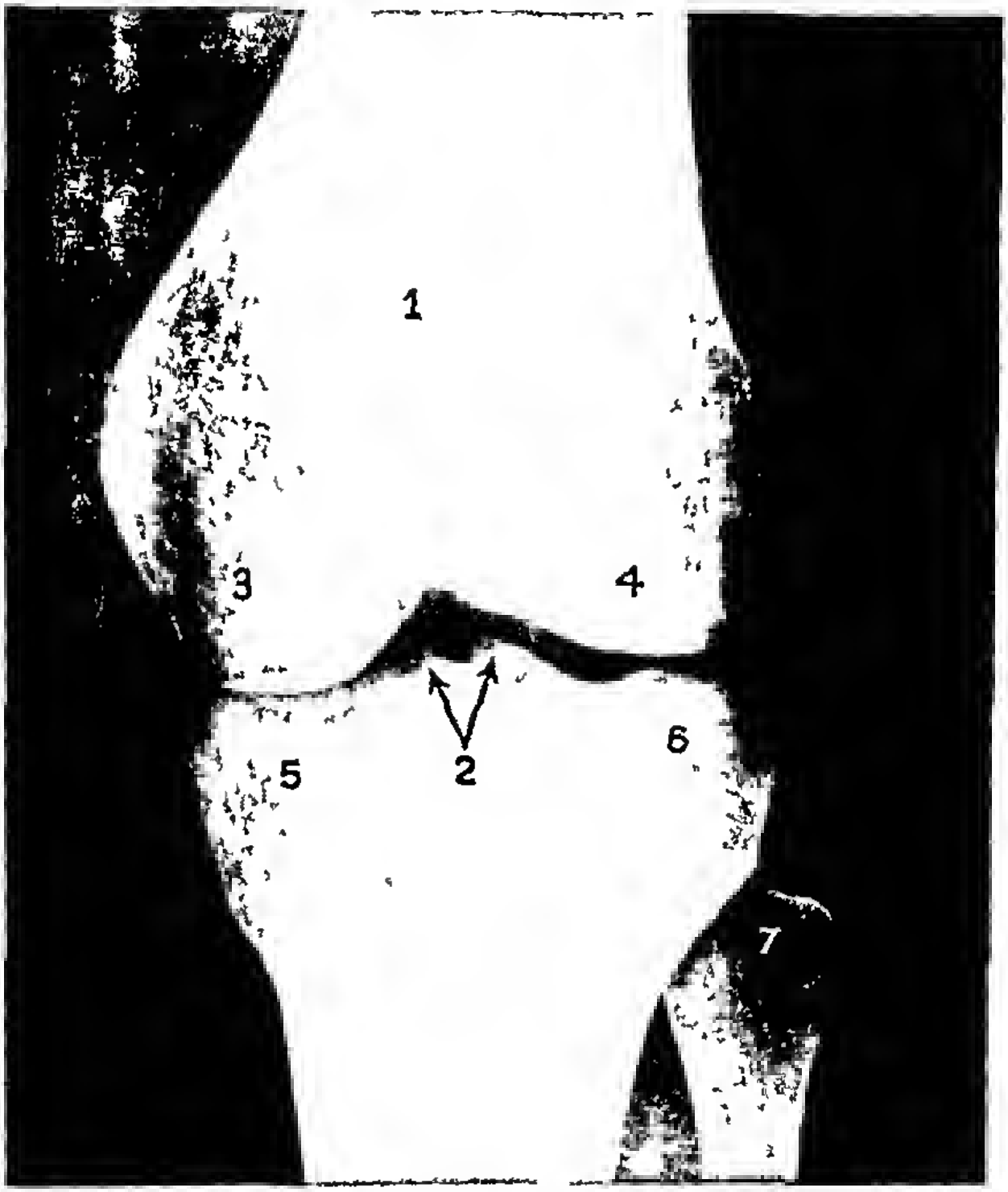


PLATE 145

Normal Knee (Antero-posterior view)

(1) Patella.
(2) Spines of tibia
(3) Internal condyle of femur
(4) External condyle of femur
(5) Internal condyle of tibia.
(6) External condyle of tibia
(7) Fibula.

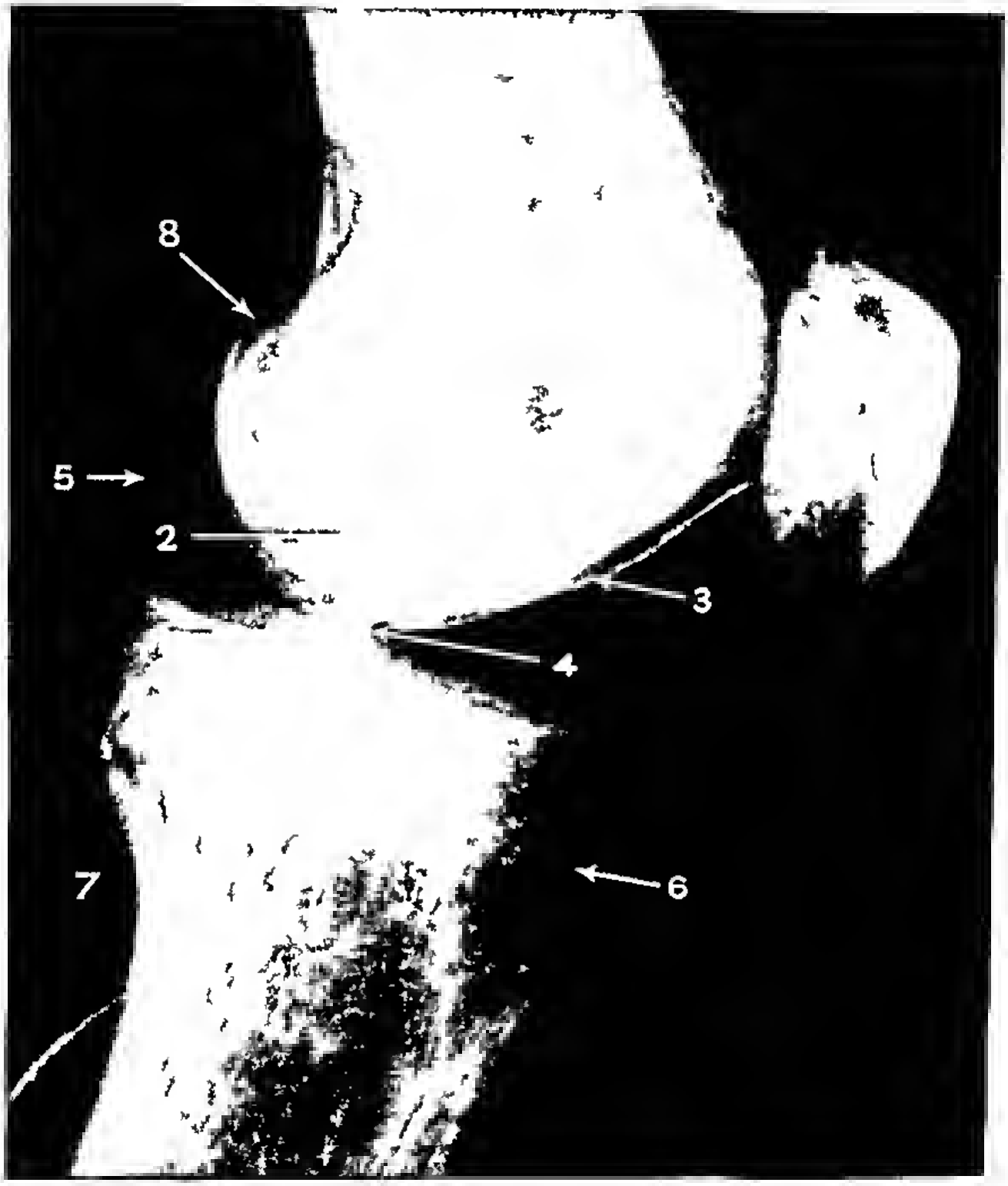


PLATE 146

Normal Knee Joint (Lateral view)

( ) Patella
(2) Internal femoral condyle.
(3) External femoral condyle
(4) Spines of tibia
(5) Fabella in gastrocnemius muscle
(6) Anterior tuberosity of tibia.
(7) Fibula Note its (normal) position behind the body of the tibia
(8) Adductor tubercle

OSTEOCHONDRITIS OF THE PATELLA

This occurs infrequently (see under Osteochondritis, page 51)

SCHLATTER S DISEASE

(Plate 149)

Osteochondritis of the tubercle of the upper tibial epiphysis (see under Osteochondritis, page 51) It shows —

(1) Raising of the tubercle of the upper epiphysis of the tibia off the diaphysis
(2) Fragmentation and sclerosis of the tubercle
(3) Swelling of soft tissues over the tubercle

PLATE 147

A. P views of knee showing Epiphyses Anterior tibial spine appears between the age of 10 12 years.

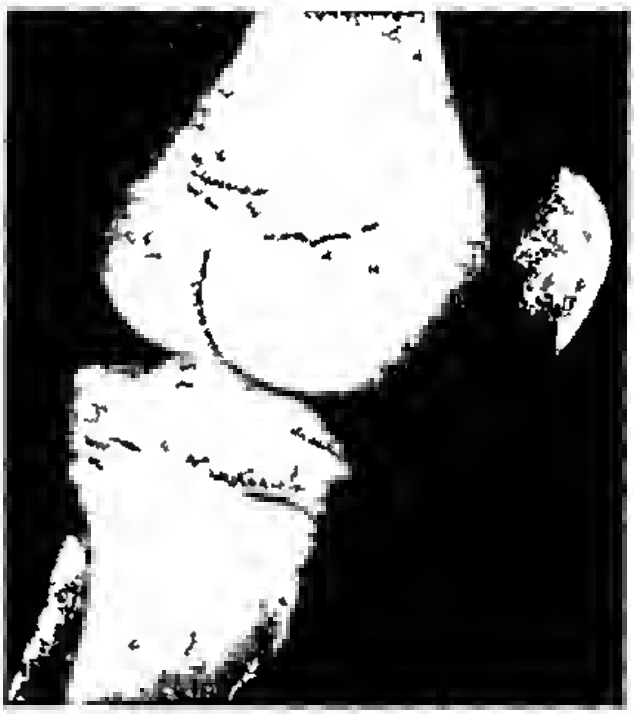


PLATE 148

Lateral view of Knee of Child aged 13 years The tibial and fibular epiphyses are unfused The anterior spine of the tibial epiphysis overlaps the anterior upper part of the body of the tibia

OSTEOCHONDRITIS DISSECANS OF THE INTERNAL CONDYLE

(Plate 150)

(1) A localised atrophy of the articular surface of the internal condyle of the femur, with an area of fragmentation and sclerosis
(2) Later a crescentic mass separates, but it is not displaced at first

(See under Osteochondritis page 51)

LOOSE BODIES IN THE KNEE (Plate 151)

These must be shown to be detached from bone in antero-posterior and lateral planes in order to avoid misinterpretation

Loose bodies may be single or multiple. They must not be confused with the fiabella at the back of the knee joint

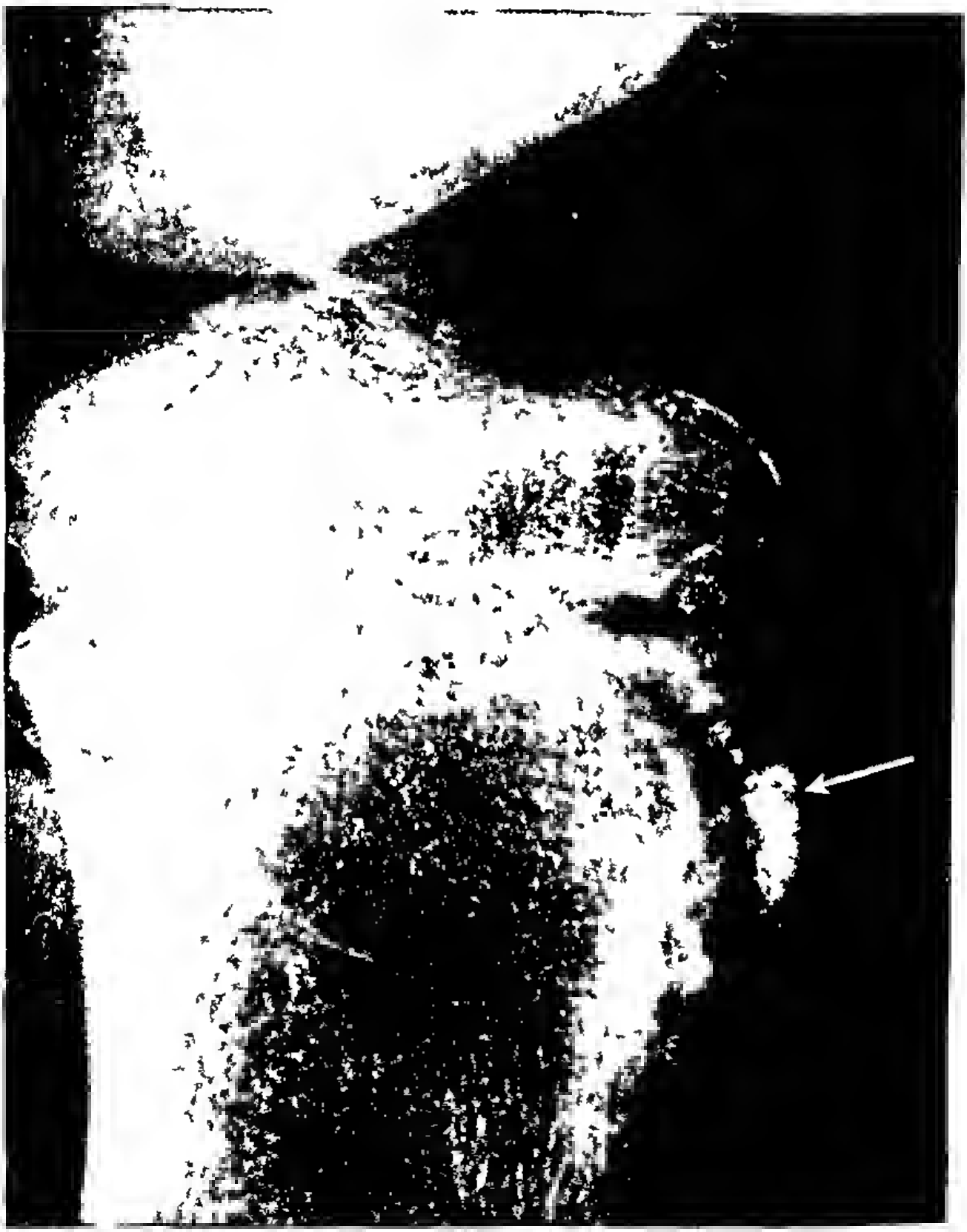


PLATE 149

Schlätter s Disease The anterior tibial tubercle is raised fragmented and irregular ind cated by arrow

PLATE 150

Osteochondritis Dissecans. The internal condyle shows a lozenge-shaped area of rarefaction with multiple small dense bodies.

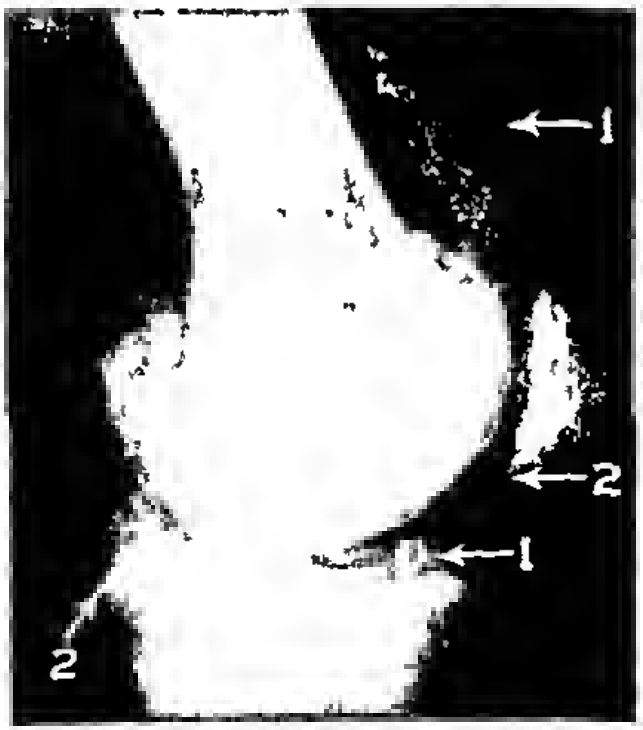


PLATE 151

Loose Bodies (1) in Osteoarthritic Knee Joint (2) Osteophytes.

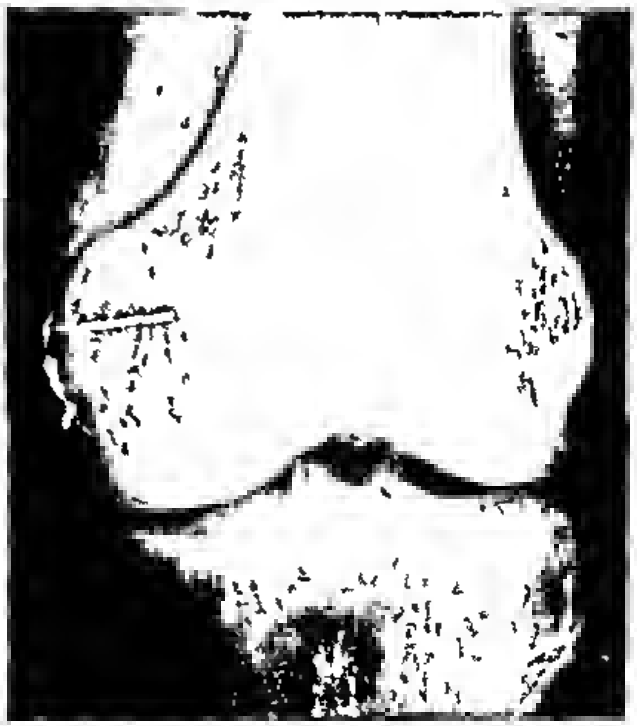


PLATE 152

Stieda's (Pellegrini) Disease indicated by arrow

THE CARTILAGES OF THE KNEE-JOINT

These are non-opaque in the normal and, therefore, injury to them cannot be seen unless they have undergone calcification.

INTERNAL DERANGEMENT OF THE KNEE

Injury to cartilage and ligaments cannot be seen from the radiographic appearance of the knee-joint, but the X-ray eliminates other conditions confusable with internal derangement of the knee, e g. :—

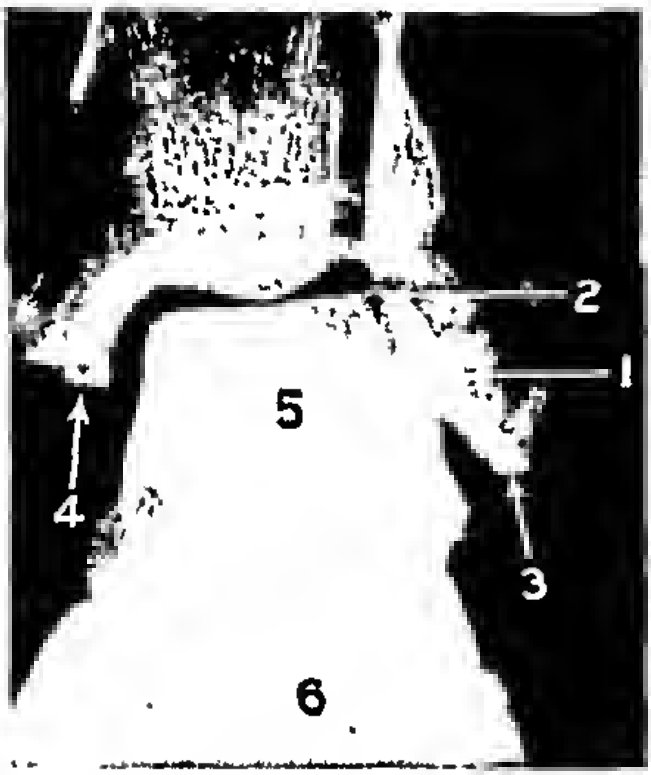


PLATE 153
Normal Ankle (A P view)
(1) Anterior border of the external malleolus
(2) Posterior border of the external malleolus
(3) Tip of external malleolus
(4) Internal malleolus
(5) Talus
(6) Calcaneus

PLATE 154.
Normal Ankle. (Lat view)
(1) Anterior border of the external malleolus.
(2) Posterior border of the external malleolus.
(3) Tip of external malleolus
(4) Internal malleolus.
(5) Talus.
(6) Calcaneus.

(1) Loose bodies.
(2) Chronic arthritis.
(3) Tuberculosis.
(4) Sarcoma of bone.

Sometimes an injured internal cartilage may undergo calcification, when it can be seen on the head of the tibia.

STIEDA'S DISEASE (PELLEGRINI)

(Plate 152)

A post-traumatic condition due to avulsion of the adductor magnus muscle or tibial collateral ligament.

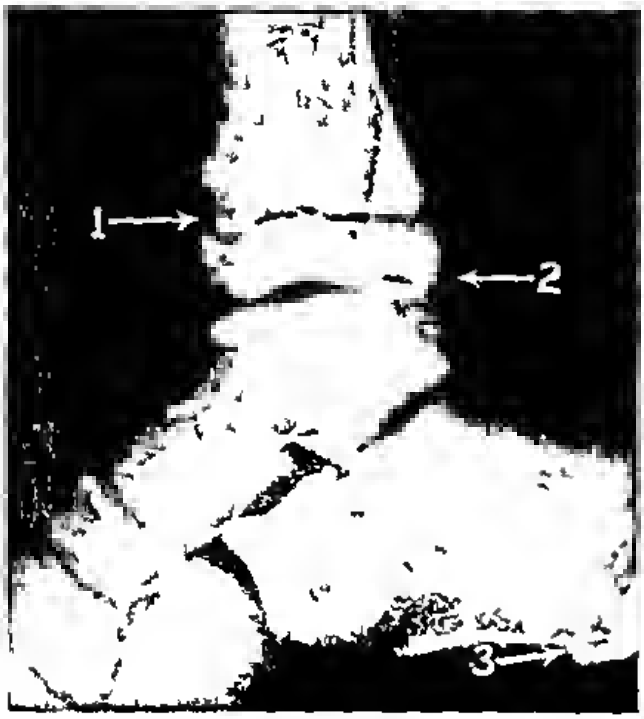


PLATE 155
Epiphyses of Ankle Joint (Lat view)
(1) Lower tibial epiphyseal line
(2) Lower fibular epiphyseal line
(3) Epiphyseal line of calcaneus

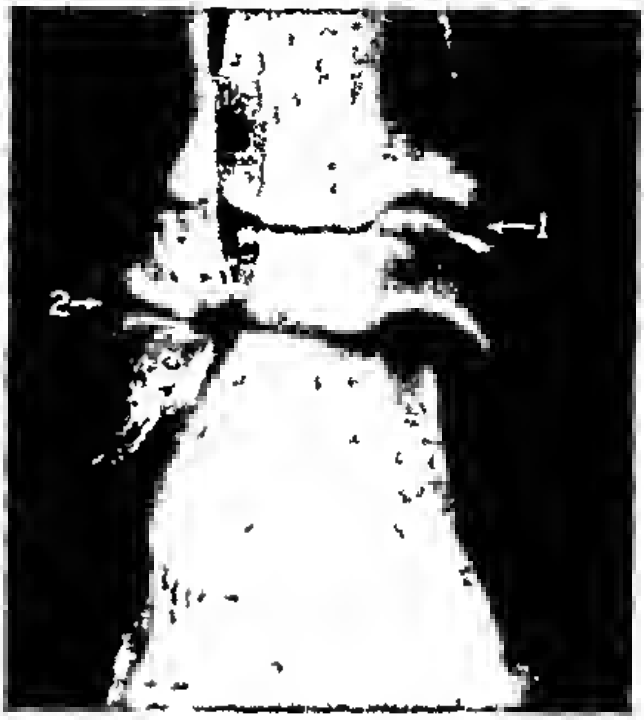


PLATE 156
Normal Ankle (A P view)
(1) Lower tibial epiphyseal line
(2) Lower fibular epiphyseal line

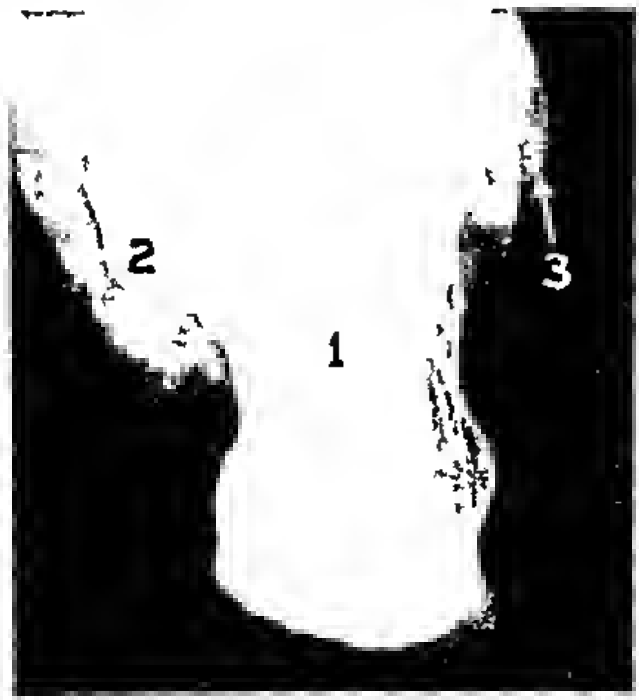


PLATE 157
Normal Bohler s view of Calcaneus
(1) Body of calcaneus. (2) Sustentaculum
(3) External malleolus.

PLATE 158
Fracture of Calcaneus. (Bohler s view) Note multiple fracture line and widening of body of bone

It appears some days after injury from calcification of a haematoma or as a type of myositis ossificans (see page 33)

SHAFTS OF THE TIBIA AND FIBULA

In the antero-posterior view the internal aspect of the fibula and external aspect of the tibia may appear thickened and serrated It is due to attachment of interosseous membrane and must not be mistaken for thickening of the cortex

PLATE 159

Normal Foot
(1) Cuneiform 1st.
(2) Cuneiform 2nd
(3) Cuneiform 3rd
(4) Cubo d
(5) Navicular
(6) Head of talus
(7) Calcaneus (sustentaculum tali)
(8) Sesamo d bone at head of 1st metatarsal Note the apparent overlap of the bases of the 2nd to the 5th metatarsals

THE ANKLE AND FOOT
(Plates 153 to 160)

The ankle is radiographed for examination in the antero-posterior and lateral views the foot in dorsi plantar and lateral views

Where fracture of the calcaneus is suspected Bohler s view is used (see Plates 157 158) to show any fracture line which may not be visualised in the lateral view and also to show the degree of impaction

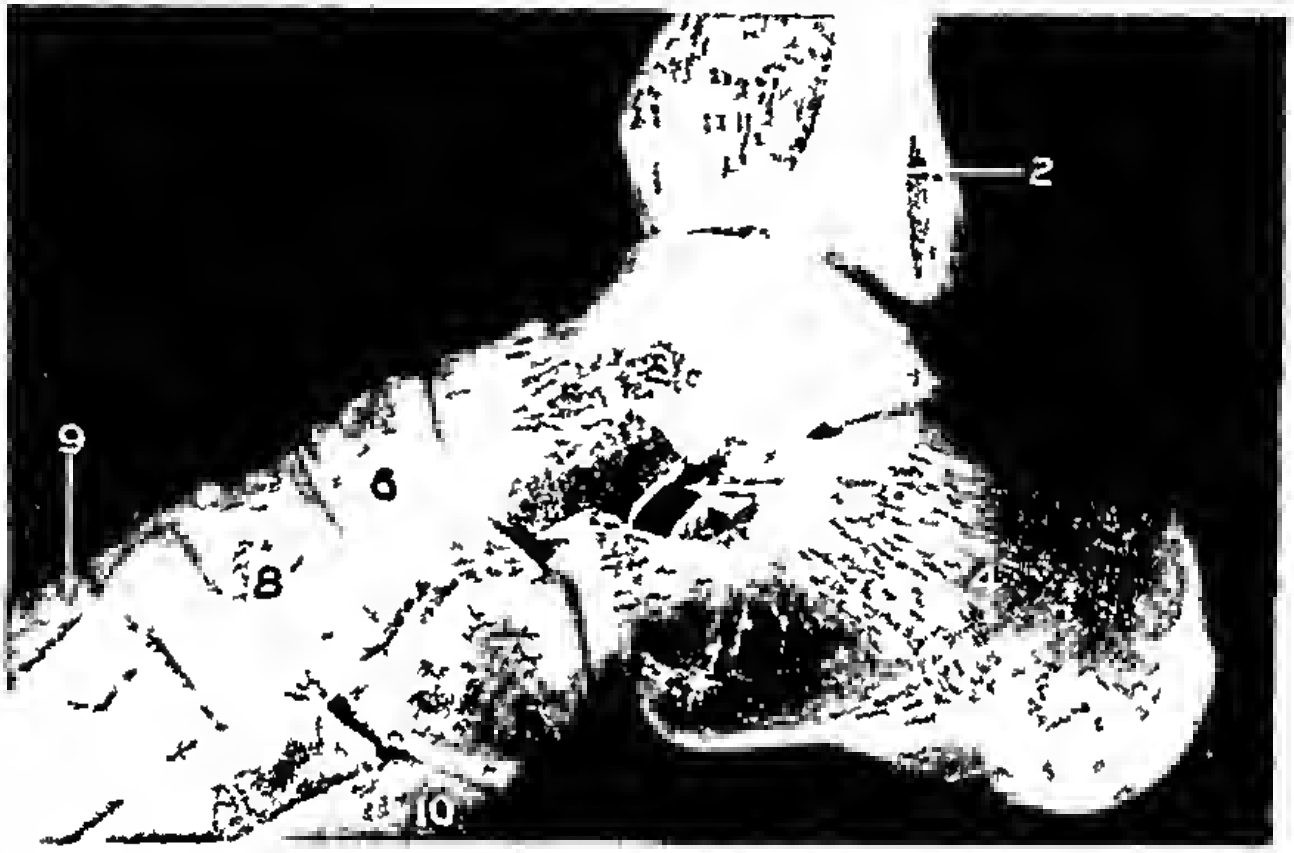


PLATE 160

Lateral view of Foot.
(1) Tibia.
(2) Fibula
(3) Talus.
(4) Calcaneus
(5) Sinus tarsi
(6) Navicular
(7) Cuboid
(8) 1st 2nd and 3rd cuneiform overlapping each other
(9) 1st metatarsal
(10) 5th metatarsal

THE ANKLE AND FOOT IN THE CHILD
(Plate 161)

Epiphyses of the ankle and foot —

Bone	*Appears at*	*Unites*
Lower end of tibia	1 month	18 years
Lower end of fibula	2 years	20 years
Os calcis	6 months i u l	16 years
Os calcis (posterior extremity)	10 years	16 years
Astragalus	7 months i u l	
Cuboid	8 months i u l	
External cuneiform	1 year	
Internal cuneiform	3 years	
Middle cuneiform	3 years	
Navicular	3 years	
Shafts of metatarsals	2 months i u l	19 years
Shafts of phalanges	2 months i u l	19 years
Heads of metatarsals	6 years	20 years
Bases of phalanges	6 years	20 years

The time of appearance of the small bones of the foot shows wide variations the first second and third metatarsals may have epiphyses at both ends

EXTRA OSSICLES AND SESAMOID BONES

Bone	*Position*
(1) Os tibialis externum	Medial to, and below, the scaphoid.
(2) Sustentaculum	Medial to talus just above calcaneus.
(3) Accessory talus	Just posterior to sustentaculum position.
(4) Trigonum	On posterior aspect of talus just above calcaneus.
(5) Peroneal sesamoid	External to cuboid.
(6) Os vesalii	At base of 5th metatarsal and external.
(7) Secondary calcaneus	Between talus, calcaneus, cuboid and navicular.
(8) Intercuneiform	Between 1st and 2nd cuneiform.
(9) Intermetatarsal	Between bases of 1st and 2nd metatarsals.

Sesamoid bones are common at the heads of the metatarsals and are often paired; they are also common at the distal end of the proximal phalanx of the big toe and distal phalanx of the second toe. The sesamoids at the proximal phalanx of the big toe are often bipartite, and must not be diagnosed as fractured.

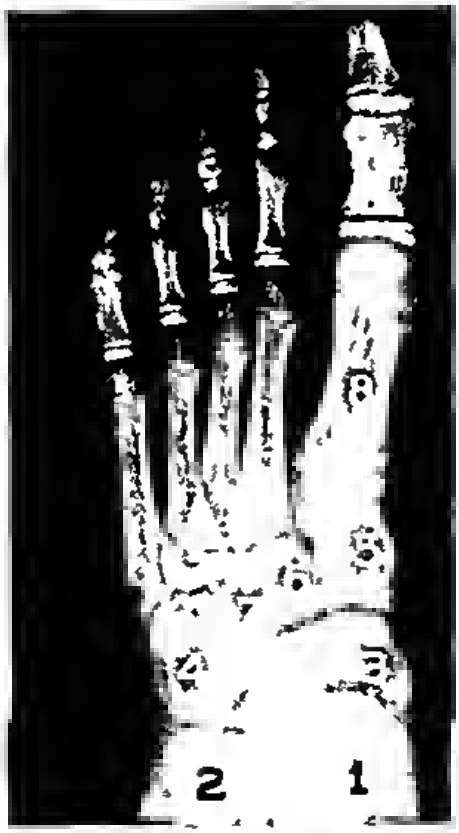


PLATE 161.

Epiphyses of Foot. The 1st metatarsal has the epiphysis at the proximal end of the body, the other metatarsal epiphyses are distal. The 5th metatarsal may also have a proximal epiphysis

(1) Head of talus.
(2) Calcaneus.
(3) Navicular
(4) Cuboid.
(5) Cuneiform 1st.
(6) Cuneiform 2nd.
(7) Cuneiform 3rd
(8) 1st metatarsal

OSTEOCHONDRITIS NAVICULAR OF BONE OF FOOT
(*Köhler's disease*) (*Plate 162*)

Bone changes —

(1) The bone is irregularly fragmented

(2) It is smaller than normal, and may be reduced to half the normal size

(3) The density is increased and irregular (see Osteochondritis, page 28)

Sometimes the navicular bone may disappear for some time

OSTEOCHONDRITIS OF SECOND METATARSAL
(Plate 163)

Bone changes —

(1) The head is flattened at its distal end is a crescentic area of increased and irregular density

PLATE 162
Osteochondritis of Navicular The bone is sclerosed and diminished in size

PLATE 163
Osteochondritis of 2nd Metatarsal The head of the 2nd metatarsal (1) is flattened the shaft is widened and shows thickening of the cortex (2)

(2) Increase in the thickness of the cortex of the shaft

(3) Often flattening of the proximal end of the proximal phalanx occurs

MARCHING FRACTURE
(Plate 164)

Bones affected. The metatarsals, usually the second, third, fourth or fifth

Bone changes —

(1) At first, when the patient complains of pain, there is often no radiographic change demonstratable

(2) Later (*i*) a fracture line across the shaft of the metatarsal is seen (*ii*) there is callus formation extending along the length of the shaft about the line of fracture (as in normal repair if callus has had time to form)

Calcaneal spurs may be present on the postero inferior aspect of the bone at the origin of the plantaris muscle and on the postero-superior aspect at the origin of the tendo achillis Unless they give rise to symptoms they are of no significance

DEFORMITIES OF THE PLANTAR ARCH

Pes cavus The arch is increased the spaces between the talus navicular and cuneiform bones are increased as seen in the lateral view

PLATE 164

Marching Fracture
A Note the fracture line at the middle of the body of the 3rd metatarsal but no other change
B Ten days later The callus formation is now easily discernible about the body of the metatarsal bone

Pes planus The arch is flattened the spaces between talus navicular and cuneiform bones are diminished as seen in the lateral view

Pes equinus The arch remains normal or slightly increased the tibia and fibula appear to articulate on the posterior aspect of the talus in the lateral view

Hallux valgus The proximal phalanx of the big toe is directed outwards and articulates with the lateral part of the head of the first metatarsal Osteophytes often occur at the metatarso phalangeal joint in the more advanced stage producing **Hallux rigidus**

NEUROPATHIC FOOT

(See under Neuropathic disease of joints, page 70)

The commonest causes are tabes, syringomyelia, psoriasis, Raynaud's disease, leprosy, yaws, and lesions of the spinal cord

Bone changes (Plate 165) —

(1) Destruction of the terminal phalanges
(2) Multiple dislocations, most marked at the tarsal joints
(3) Irregular loose body-formation
(4) Marked bone atrophy

PLATE 165
Syringomyelia

SHOULDER GIRDLE

(Plate 166)

The shoulder girdle is radiographed for examination in the antero-posterior and postero-anterior views A true lateral view is unobtainable Stereoscopic antero-posterior radiographs must be made when the true planes of the bones have to be visualised

In a negative in which the shoulder-joint is well seen, the external end of the clavicle may appear cystic from over-exposure blotting out the bone detail of the clavicle The position of the greater and lesser tuberosities overlying each other in the antero-posterior view may produce a cystic appearance in the external part of the anatomical neck A picture taken in full internal rotation will show the true position

PLATE 166

Normal Shoulder Joint

(1) Clavicle Note that the outer end may appear cystic
(2) Acromial process
(3) Acromio clavicular joint
(4) Coracoid process of scapula
(5) Glenoid cavity
(6) Head of humerus
(7) Greater tuberosity of humerus
(8) Lesser tuberosity of humerus
(9) Intertubercular grove

Note rotation of the humerus may make the area between the tuberosities and neck of the humerus appear to be cystic

EPIPHYSIS OF THE SHOULDER GIRDLE
(Plates 167, 168)

Bone	*Appears at*	*Union*
Body of scapula	2 months, i u l	—
Coracoid process	14 months	15 years
Acromion ,,	15 years	22 ,,
Base of scapula	17 ,,	25 ,,
Head of humerus	4 months	20 ,,
Greater tuberosity	3 months, 6 years	20 ,,
Lesser tuberosity	4 months	20 ,,

The head of the humerus, greater and lesser tuberosity, unite together between the fifth and sixth year

PLATE 167
Epiphysis of Humerus of Child Aged 3 Years.
(1) Head of humerus (2) Greater tuberosity

PLATE 168
Shoulder of Child Aged 7 Years The head, greater and lesser tuberosity are united into one epiphysis.

CLAVICLE

UPWARD DISLOCATION OF THE OUTER END OF THE CLAVICLE

Following an injury to the shoulder, the radiograph shows the outer end of the clavicle to he higher than the acromion This indicates a dislocation of the acromio-clavicular joint In the normal, a smooth line can be drawn from the upper margin of the clavicle to the outer edge of the acromion process In rupture of the coraco-clavicular ligament, the distance between the coracoid process and clavicle is increased This can often only be confirmed by comparing with the opposite shoulder-joint

DISEASES OF THE UPPER END OF THE HUMERUS

TUBERCULOSIS

As well as the typical tuberculous lesion caries sicca occurs and is practically confined to this region

Bone changes of caries sicca (Plate 169)

(1) An area of erosion of the bone is present usually between the upper part of the head and the greater tuberosity

(2) *The formation of multiple small sequestra*

(3) Ground glass type of atrophy of the bone

PLATE 169
Caries Sicca

PLATE 170
Subcoracoid Dislocation. (1) The head of the humerus is displaced out of the glenoid cavity (2)

OSTEOARTHRITIS (see page 66)

LOOSE BODIES

Loose body formation rarely occurs in the shoulder joint calcification may occur in bursae around the joint most commonly between the deltoid muscle and the greater tuberosity The exact position of the loose body can only be visualised by stereoscopic examination

DISLOCATION OF THE HEAD OF THE HUMERUS (Plate 170)

This is most often subglenoid or subcoracoid when the head of the humerus is seen to be absent from the acetabulum Posterior dislocation can be diagnosed only

by stereoscopic films to show the spatial relation of the head of the humerus to the glenoid, the humeral head appearing in a posterior dislocation behind the glenoid cavity, but in a single radiograph it may appear in the normal position

ELBOW-JOINT

The elbow joint should be X-rayed in the antero-posterior and lateral planes Care must be taken that the hand is fully supinated in the former view In the true lateral position, the head of the radius lies further forwards than the ulna, and this must not be mistaken for a dislocation (Plate 171)

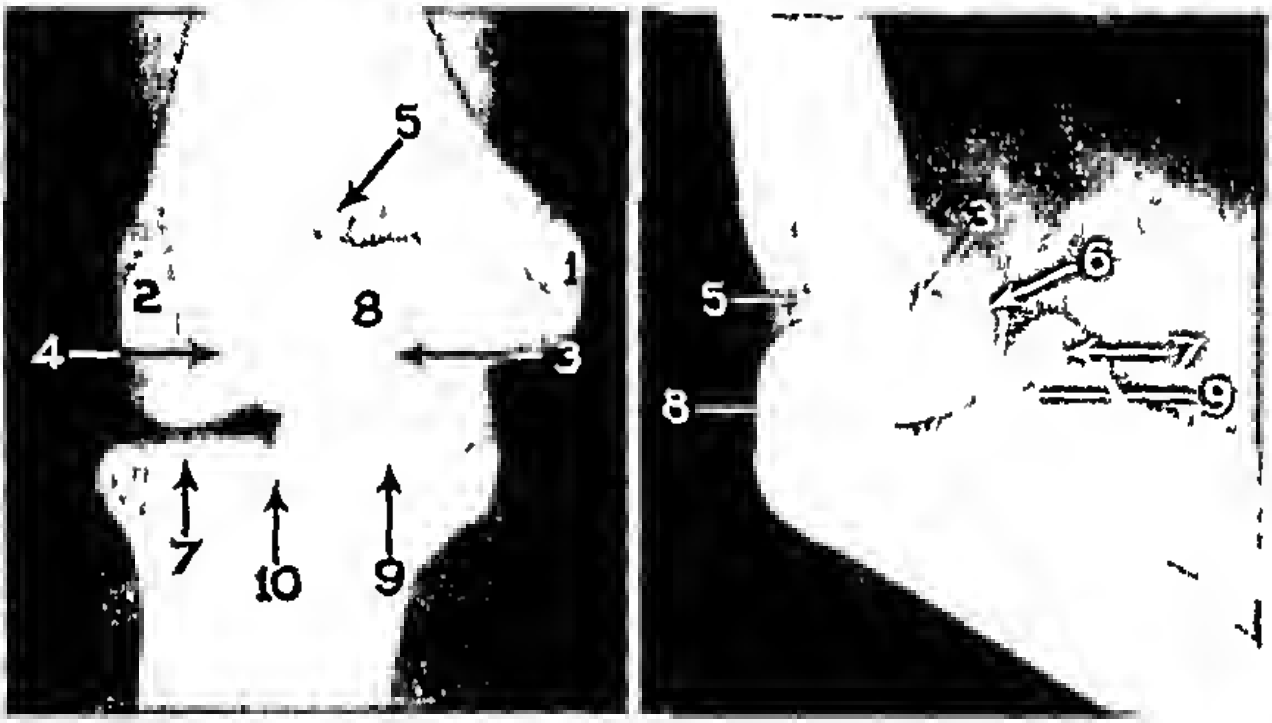


PLATE 171

Normal Elbow joint Antero posterior and lateral views

(1) Medial epicondyle of humerus.
(2) Lateral epicondyle of humerus
(3) Trochlear
(4) Capitellum
(5) Olecranon fossa
(6) Coronoid fossa
(7) Head of radius.
(8) Olecranon of ulna
(9) Coronoid process of ulna
(10) Radial notch of ulna

Epiphysis of the elbow-joint (Plates 172 173, 174)

Bone	*Appears at*	*Unites*
Internal condyle of humerus	4 years	18 years
Trochlear	12 ,,	19 ,,
Capitellum	2 ,,	19 ,,
External condyle	13 ,,	19 ,,
Head of radius	6 ,,	16 ,,
Olecranon	10 ,,	17 ,,

The trochlear, capitellum and external condyle unite about the sixteenth year The olecranon may be formed from three separate centres

Osteochondritis of the capitellar epiphysis occurs rarely (see Osteochondritis, page 51)

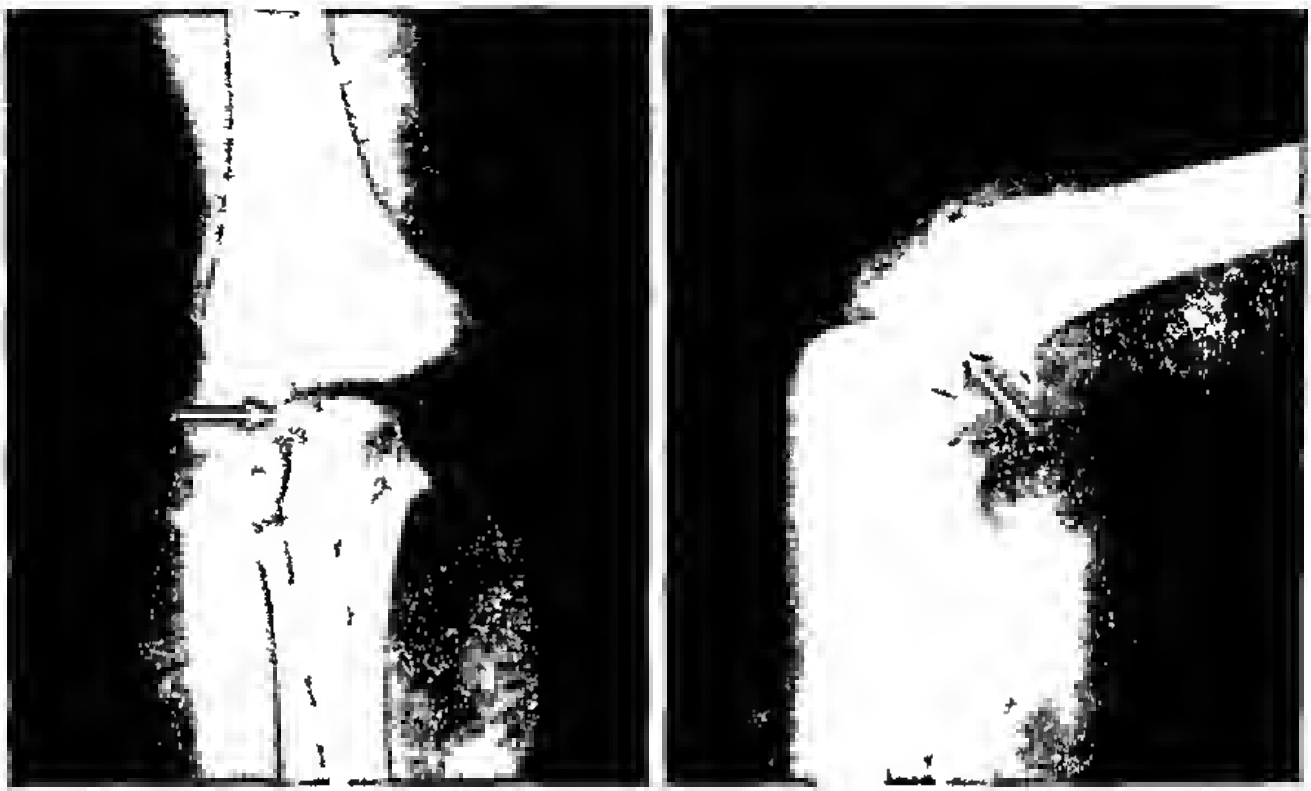


PLATE 172
Epiphysis at 2 Years of Age (A P and Lat. views) Capitellar epiphysis indicated by arrow

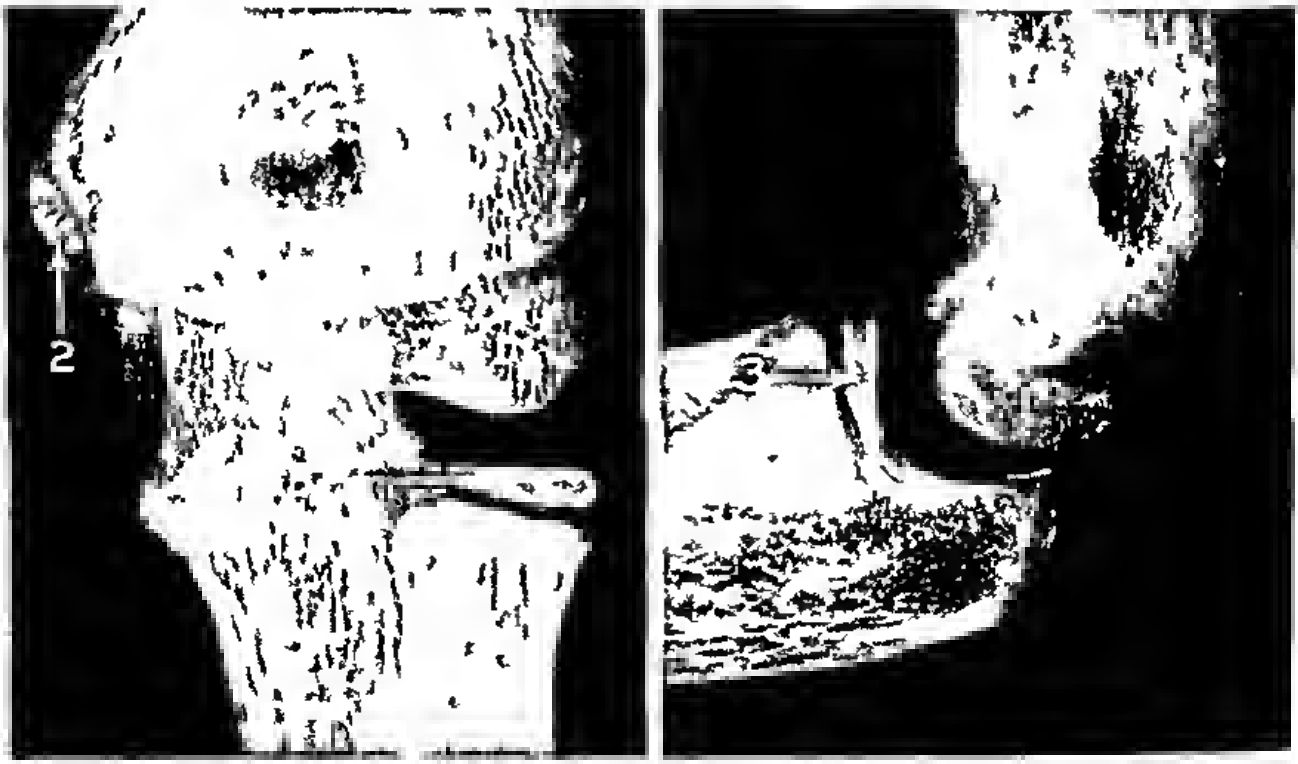


PLATE 173
Epiphysis at Age 6 Years (A P and Lat views) (1) Capitellar ep physis (2) Internal ep condyle (3) Head of radius

Myositis ossificans may occur after injury to the elbow-joint as a complication (see page 33).

SHAFTS OF RADIUS AND ULNA

In the antero-posterior views, the cortex of the opposing edges of the radius and ulna may appear thickened. This is produced by the attachment of the interosseous membrane. It must not be mistaken for thickening of the cortex.

LOWER END OF RADIUS AND ULNA

Epiphysis.

Bone	*Appears at*	*Unites*
Lower end of radius	3 years	20 years
Lower end of ulna	5 years	20 years

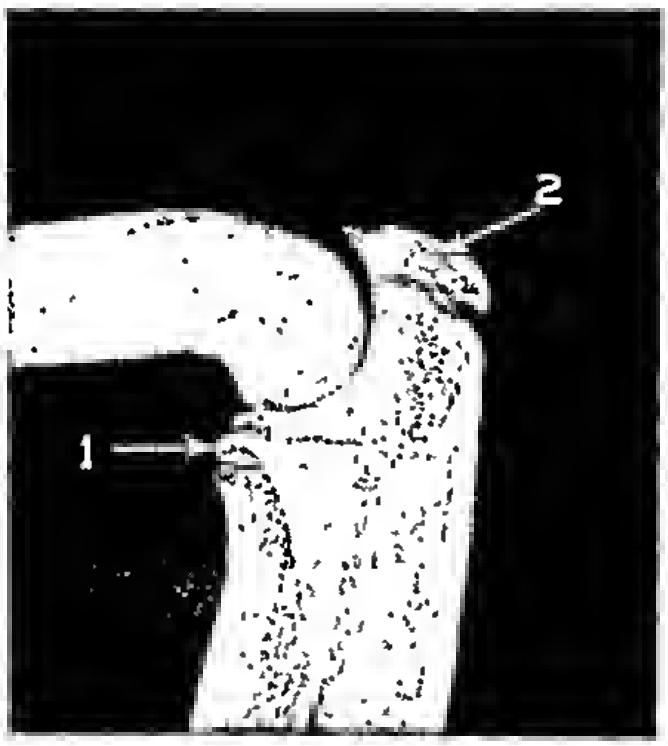


PLATE 174.
Elbow-joint of Young Adult Aged 16 Years.
(1) Epiphysis of head of humerus.
(2) Epiphysis of upper end of olecranon.

Diseases of the lower radio-ulnar epiphysis in children.

(1) Infantile rickets (see page 46).
(2) Renal rickets (see page 48).
(3) Scurvy (see page 46).
(4) Syphilis (see page 39).

MADELUNG'S DISEASE OF THE WRIST

In Madelung's disease there is retardation of the normal growth of the lower ulnar epiphysis. It is said to be post-traumatic or to follow a mild infective epiphysitis.

The radiographic appearance is characteristic (Plates 176, 177). The ulna is shorter

PLATE 175

Supracondylar Fracture (A P and Lat. views) The fracture line is indicated by arrow the lower fragment is displaced forwards

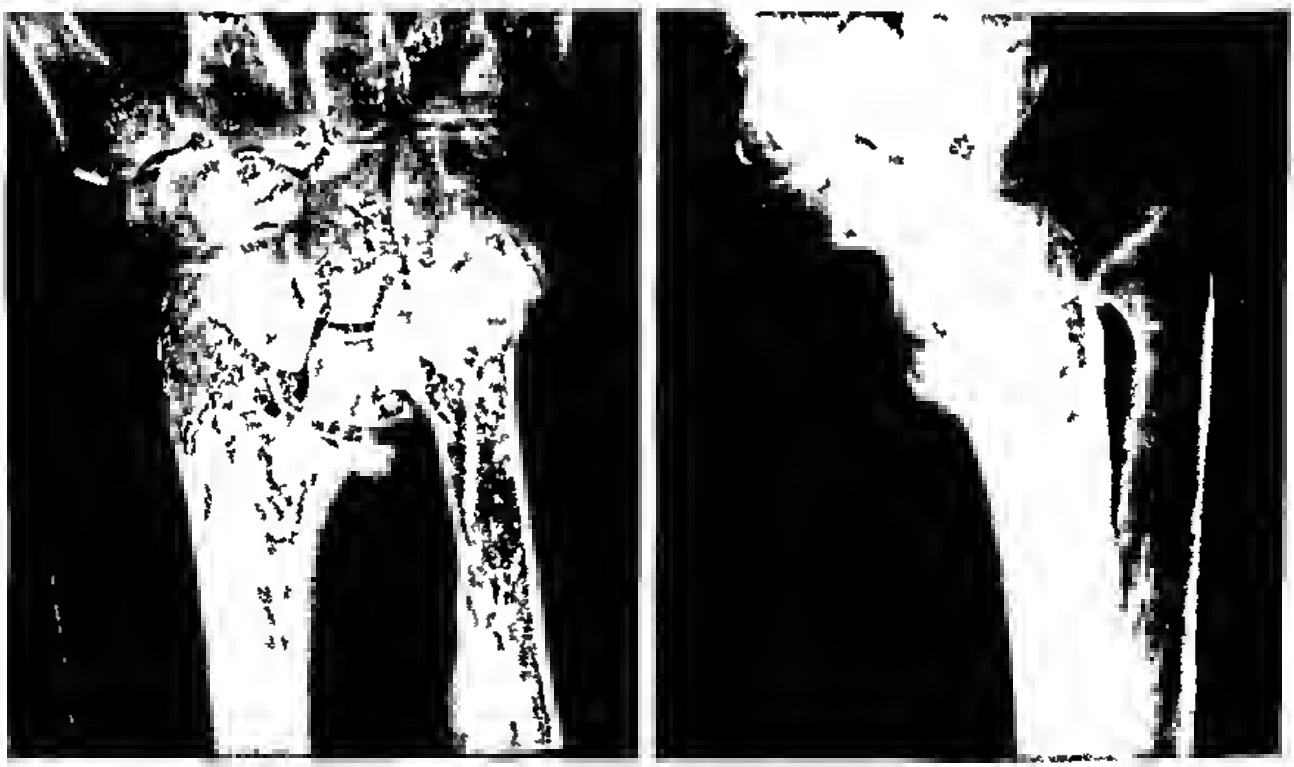


PLATE 176

Madelung's Deformity (A P and Lat views) The radius is short The ulna is dislocated backwards and lies behind the triquetrum and pisiform bones

than normal, so that the radius appears to be too long The lower radio-carpal joint is at a more distal level in relation to the ulnar-carpal joint than in the normal This produces a permanent ulnar deviation of the carpal bones The lower ulnar styloid process is rotated backwards with subluxation backwards at the lower radio-ulnar joint, so that the lateral border of the ulnar, instead of being concave towards the radius, shows a straight or convex border

THE HAND
(Plate 178)

The hand is radiographed for examination in the antero-posterior and lateral views

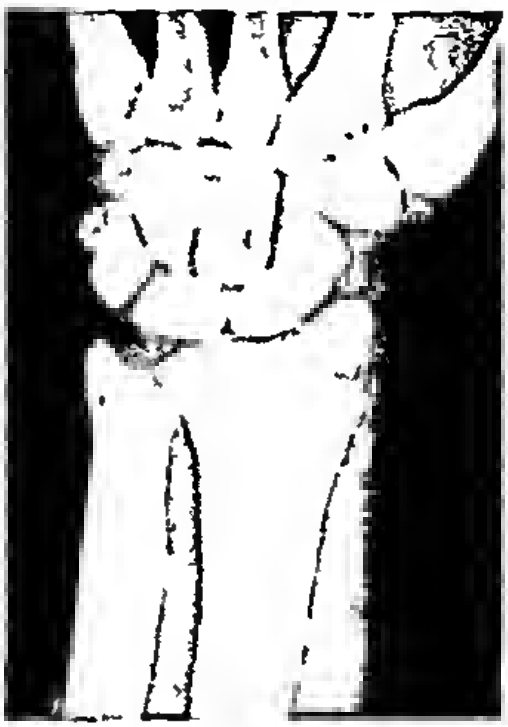


PLATE 177
Madelung's Deformity of Wrist. (Mild degree)
Note that the lateral border of the ulna is concave towards the radius instead of convex.

THE HAND IN THE CHILD

Epiphyses and ossifications.

Bone		*Appears at*	*Union*
Carpus	Os magnum (Capitate)	1 year	—
	Uncıform (Hamate)	1½ years	—
	Pyramidal (Triquetral, cuneiform) ..	3 „	—
	Trapezium (Os Multangulum Majus) ..	4 „	—
	Semilunar (Lunate)	4 „	—
	Scaphoid (Navicular)	5 „	—
	Trapezoid (Os Multangulum Minus) ..	6 „	—
	Pisiform	10 „	—
	Head of metacarpals	5 „	19 years
	Base of phalanges	5 „	19 „

The first metacarpal has its epiphysis at the proximal end and sometimes at the distal end as well This appears at the seventh year

Plate 179 shows the development of the carpal bones at the 2nd 7th and 11th years

EXTRA OSSICLES OF THE HAND

(1) Os triangulum lies between the radius and lunate
(2) Pisiform secundarium lies between the ulna and pisiform

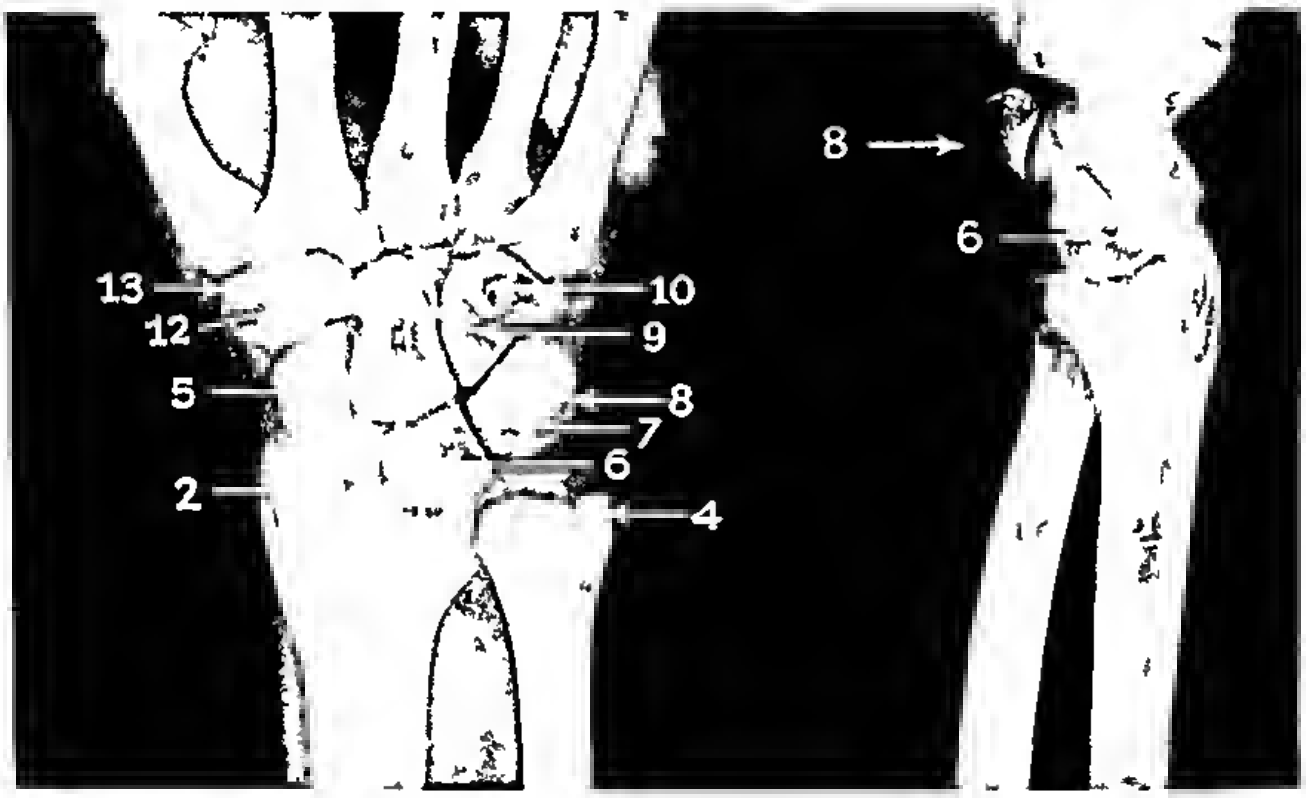
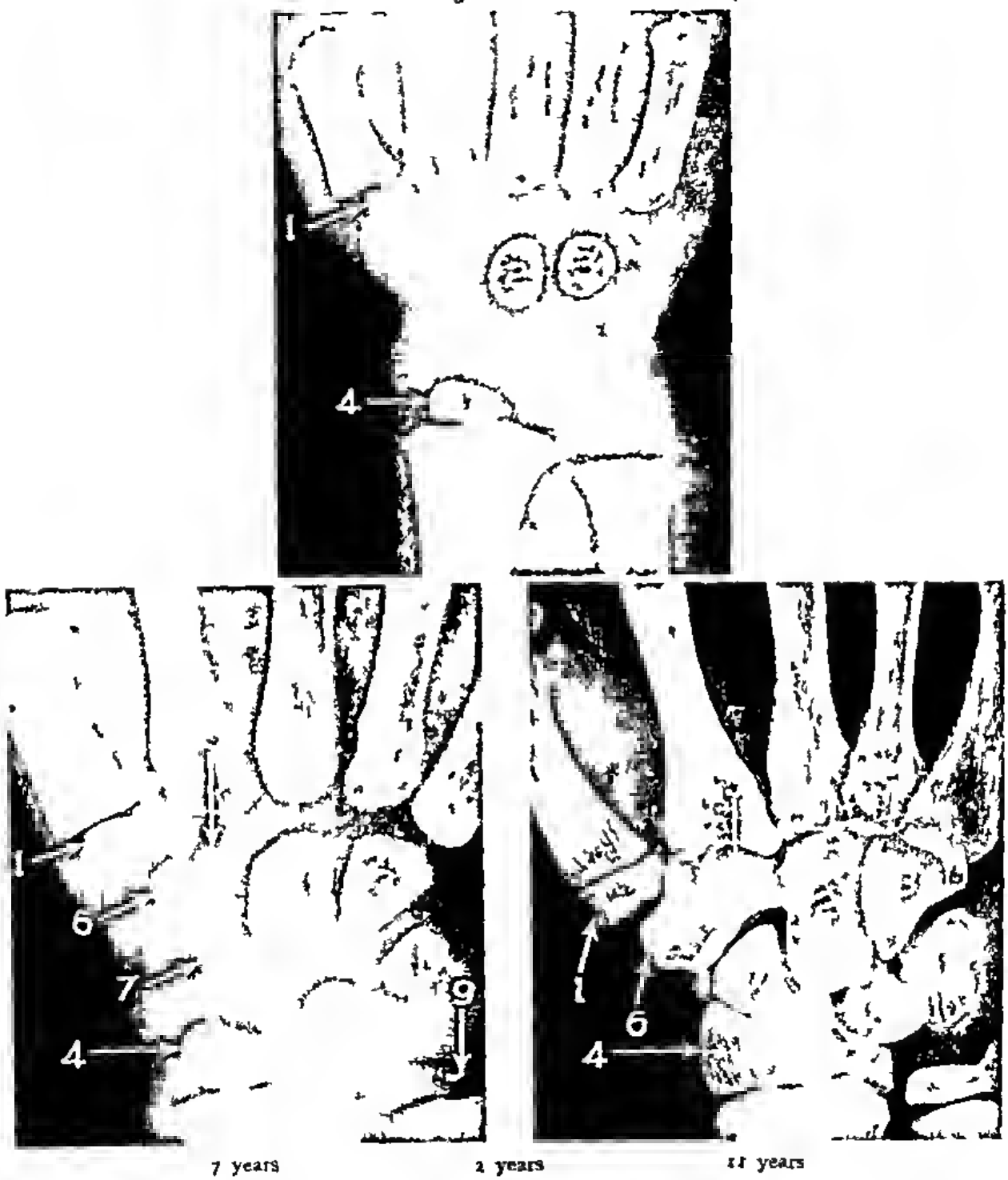


PLATE 178

Hand (A P and Lat views)
(1) Radius
(2) Styloid process of radius
(3) Ulna
(4) Styloid process of ulna
(5) Navicular
(6) Lunate
(7) Triquetral
(8) Pisiform
(9) Hamate
(10) Unciform process of hamate
(11) Capitate
(12) Lesser multangular
(13) Greater multangular

In the lateral view of the hand the concave articular surface of the lunate for the capitate bone is directed upwards In forward d slocation of the lunate the bone is rotated and the concave articular surface looks forwards
The lateral ulna and medial radial borders are both concave

(3) Os vesalianum lies between the triquetrum and fifth metacarpal
(4) Hypolunate lies between the navicular lunate and capitate
(5) Radiale externum lies between the navicular and the multangular majus
(6) Epilunate lies between the lunate and the capitate
(7) Styloideum lies at the base of the third metacarpal
(8) Secondary trapezoid lies between the bases of the fourth and fifth metacarpals



7 years 2 years 11 years

PLATE 179

Development of Carpal Bones at Age 2 7 and 11 Years

(1) Epiphysis of proximal end of 1st metacarpal
(2) Capitate
(3) Hamate
(4) Lower epiphysis radius
(5) Lesser multangular
(6) Greater multangular
(7) Navicular
(8) Lunate.
(9) Lower epiphysis of ulna.
(10) Pisiform.
(11) Triquetral

SESAMOIDS OF THE HAND

The hand may show the following sesamoids —

At heads of the first, fourth and fifth metacarpals two sesamoids

At heads of the second and third metacarpals single sesamoids

At the distal end of the proximal phalanx of the thumb and the distal end of the middle phalanx of the second finger single sesamoids

CARPAL BONES

Scaphoid

(1) In fracture of the scaphoid, a distinct fracture line must be visualised (Plate 180)

PLATE 180
Fracture of the Scaphoid indicated by arrow

(2) The bipartite scaphoid is developed from two separate centres which remain unfused Each bone shows a distinct cortex which distinguishes it from a fracture

(3) Osteochondritis (Kienböck s disease) is often bilateral (see page 57)

In radiography of the scaphoid it is necessary that the bone should be radiographed so that its longest axis is seen This can only be done by taking care that the hand is X rayed in the postero-anterior view with *ulnar deviation* of the hand because it is only in ulnar deviation that the long axis of the scaphoid lie in the long axis of the hand

Semilunar

(1) Osteochondritis (see page 57)

(2) Dislocation This is usually associated with fracture of the scaphoid (Plate 181) In the lateral view the crescentic articular surface points forwards instead of upwards The distal carpal bones lying behind are approximated to the radius and ulna

PLATE 181.

Dislocated Semilunar Note its rotation forwards and shortening of the space between the distal carpal bones and head of the radius.

PLATE 182.

Flake Fracture of Cuneiform, indicated by arrow.

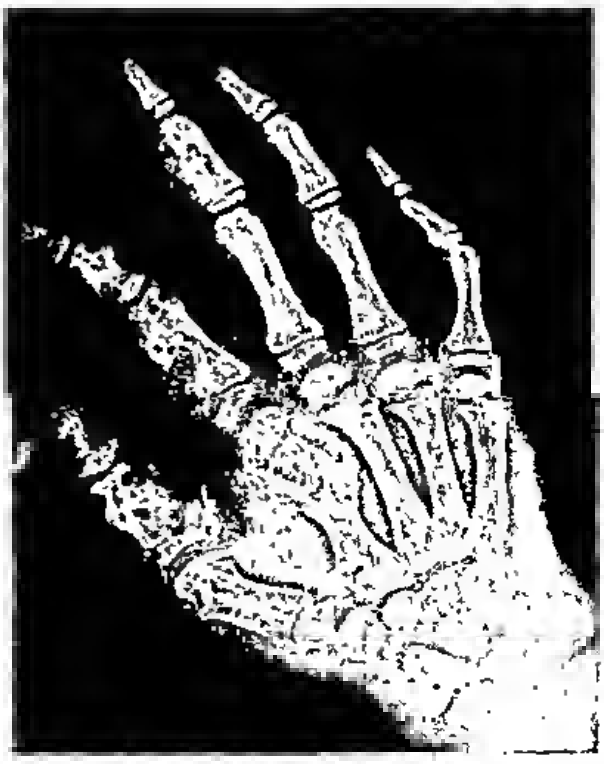


PLATE 182A.

Tuberculous Dactylitis.

FLAKE FRACTURE OF THE TRIQUETRUM (CUNEIFORM)
(Plate 182)

Sometimes when there has been injury to the hand, in the lateral view a small flake of bone is seen lying detached on the posterior aspect of the carpal bones This is a small fragment detached from the triquetrum

DISEASES OF THE CARPAL BONES

Arthritis (see page 64)

DISEASES OF PHALANGES

Achondroplasia. The phalanges are expanded most markedly at the distal ends (see page 50)

Acromegaly. Tufting of the phalanges occurs at the distal ends (see page 81)

Gout Earliest changes occur in the phalanges (see page 52)

Neuropathic disease (see page 69)

Pseudo-hypertrophic pulmonary osteoarthropathy (see page 53)

Simple cysts (see page 57)

Multiple enchondromata (see page 56)

DACTYLITIS
(Plate 182A)

Causes. Tuberculosis, osteomyelitis and syphilis (see pages 38, 34, 39)

Site Metatarsals, metacarpals and phalanges

Characteristic changes.

(1) Thinning of the cortex
(2) Absorption of the cancellous bone
(3) Small multiple cyst formation
(4) Infrequently, small sequestra formation

Differential diagnosis.

Multiple enchondromata (see page 56), which show "enchondroma spots"

Simple cysts (see page 57) The phalanges show no change beyond the presence of the cyst which may be fractured

THE CHEST

CHAPTER IV

THE CHEST

The excellence of the chest radiographs and the amount of information which can be obtained from them beyond that obtainable by the ordinary methods of physical examination, has reached such a standard of perfection that to-day no chest examination can be said to be complete before a radiograph of the chest has been examined This is of primary importance in the detection of latent tuberculosis of the lung in candidates for life insurance or any work in which " trade lung " can develop Radiographic examination is carried out rigorously as a routine in the mines of South Africa, but has not yet received the attention which it deserves in England The systematic X-ray examination of the chest of candidates applying for work which is likely to lead to damage of the lung, or those working under conditions in which active tuberculosis is likely to develop because of the nature of the work, would save the insurance companies much money in compensation for illness and disablement, and prevent unsuitable workers entering industries for which they are already unsuited when they apply The deviation of such workers to open-air work would be to their benefit, as well as to that of the industry in general

It must not be thought that an X-ray examination alone can justify a diagnosis of pulmonary tuberculosis, but the detection of any abnormal shadow in the lung field means that sputa examinations must be made and until the cause for the abnormal shadow in the lung field has been discovered the examining physician should not give a report on the condition

RADIOGRAPHS OF THE CHEST

The chest should be X-rayed for topographical survey with the X-ray tube at 2 metres from the film to prevent distortion

The picture should be of such density that it should show lung markings, heart and mediastinal outline, without the outline of the lower dorsal spine being seen through the heart shadow

It is of the greatest importance that " true " antero-posterior or postero-anterior views should be obtained because of the complicated nature of the organs of the chest and their relation to each other That the X-ray picture has been taken in the " straight " position should be checked on the radiograph by seeing that the sternal ends of the clavicle appear equidistant from the spines of the upper dorsal vertebra which are seen through the " clear space " of the trachea The mediastinal mass forms a septum between the two lung fields, and if the patient is inadvertently turned to right or left, there appears an apparent widening of the mediastinal mass, displacement of the heart shadows and an inequality of the two sides of the chest wall

The patient can be X-rayed for chest examination either lying prone or standing upright The upright position allows the detection of any pleural effusion which is often diminished or masked in the prone position The upright postero-anterior view is the most satisfactory for the usual examination, the X-ray tube being centred

at the level of the seventh dorsal vertebra or at the centre of the 15 ×12-inch film which covers the chest area The patient stands with his arms internally rotated as this causes the scapulae to be drawn forwards and laterally, thus diminishing their shadow over the lung fields It is important that the scapulae should cover equal areas of lung field, as if unequal areas are covered, the lung fields will be unequally illuminated

Examination of the chest film.

(1) The position of the mediastinal mass, and whether the trachea is central or deflected, should be noted

(2) The diaphragm levels should be noted, the right is usually higher than the left

(3) In women, the position of the nipples and breasts must be defined to prevent misinterpretation of their shadows as changes in the lung They can usually be traced extending out into both axillae

(4) The vertebral borders of the scapulae are seen in the upper and mid-external zones and their outline must be defined to prevent errors in diagnosis They must not be mistaken for areas of consolidation

(5) In muscular patients the sterno-mastoid muscle can be seen at its insertion into the clavicle or first rib, and must not be confused with abnormal opacities or cavities at the apices

(6) At the upper end of the mediastinal shadow, the trachea is seen as a translucent " clear space ' which can often be traced as far as its bifurcation (4th dorsal vertebra) In the normal chest it is central, it is deviated to either side by pathological changes

(7) Calcification in costal cartilages must not be confused with abnormalities in the lung, they can be traced as lying on the line of the costal cartilage between the sternum and the sternal ends of the ribs and are therefore restricted to the inner third of the lung field

(8) The heart and mediastinal shadows occupy the central part of the film, at the mid-point the shadow widens at the hilum of the lung It is seen more clearly on the right than on the left side, as on the latter the left border of the heart obscures it

It is impossible to lay down any arbitrary rules for the size of the normal hilar shadow In town dwellers, the hilar shadow is larger and of harder outline than in the country dweller

(9) The normal pleura cannot be seen No area in the lung fields in the normal should be apparent in which lung tissue cannot be made out

(10) Deviation of the mediastinum produced by scoliosis of the dorsal spine can be detected from the abnormal widening of the intercostal spaces on one side and narrowing on the other It is confirmed by a film of the dorsal spine

Pathological changes in the lung fields. Pathological changes in the chest often involve both the mediastinal and lung tissue together, but for descriptive purposes they must be considered separately The recognisable changes which can be seen in the lung field depend on the formation of abnormal opaque and translucent areas From the type of opacity which appears in different conditions, the diagnosis is made While the X-ray appearance of disease, when the shadows are fully developed, is in most cases diagnostic, confusion may arise in the earlier stages before the picture is typical, if it is not read in the light of the full clinical knowledge of the case In some cases it is necessary to take radiographs at intervals of days or weeks to arrive at a true diagnosis

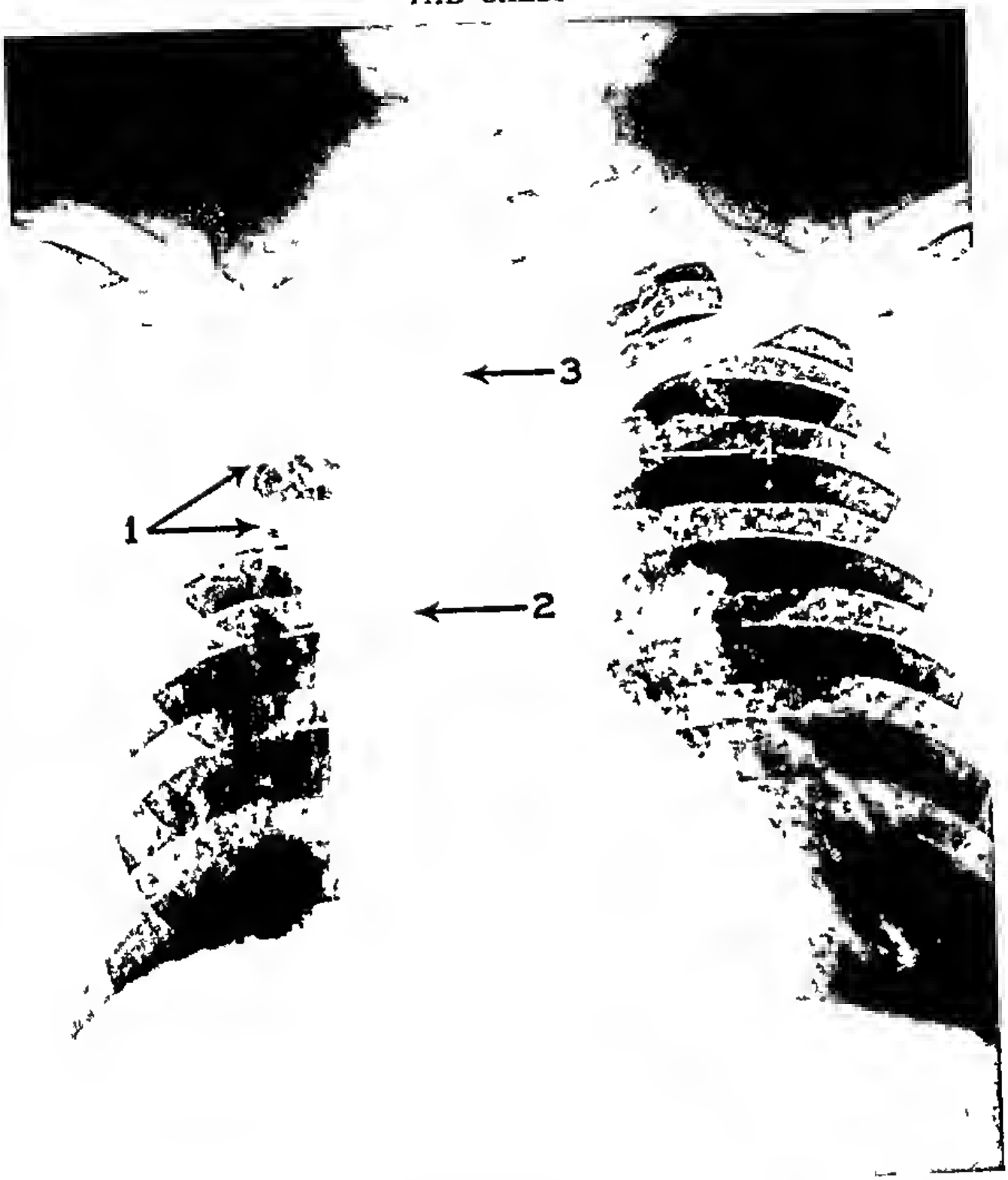


PLATE 183

Fibrosis of Lung

(1) Fibrosed lung area
(2) Mediastinum displaced to right
(3) Trachea displaced to right
(4) Aortic notch

MEDIASTINAL CHANGE IN DISEASE

The normal trachea can be seen as a translucent tube (clear space) stretching from the neck above to the level of the fourth dorsal vertebra below, in its lower part it is often partly obscured by the central heart and aortic shadow

Deviation of the mediastinum. The mediastinal mass may in disease be deviated to one or the other side, and with it the trachea

(1) *Causes of deviation towards the affected lung* —

(*a*) By traction of the fibrous tissue in the affected lung field (Plate 183) It is seen typically in fibrosed lung conditions

(*b*) In collapse of the lung

(2) *Causes of deviation away from the affected lung* —

(*a*) By a pleural effusion It is seen typically as a homogeneous opacity of the affected side, most opaque at the base

(*b*) By a large growth near one hilum, displacing the mediastinum

(*c*) By a pneumothorax with a large positive pressure

Causes of broadening of the mediastinal shadow (Plate 184)

I *Causes of gross mediastinal enlargement,*

(A) Dilatation of the aorta or aneurysm (see under Heart section)

(B) Dilatation of the oesophagus The differential diagnosis depends on demonstrating the dilatation by screening in the left lateral position (see under Oesophagus section)

(C) Neoplasm (Plate 184) The diagnosis first depends on eliminating groups (A) and (B) The diagnosis of the exact nature of a mediastinal tumour is very difficult, but since the prognosis and the treatment, which is usually X-ray therapy, depends on its exactitude, every care must be taken that a correct diagnosis is made The X-ray appearance from one or a series of films, all taken at the same time, is rarely diagnostic The patient must be thoroughly examined and all other collateral evidence must be scrutinised (1) A careful examination must be made of the patient for evidence of a primary neoplasm in the breast, testis or other organ (2) A complete blood count should be made to exclude leukaemia (3) An X ray examination of the oesophagus for neoplasm should always be made in every case of enlarged mediastinal tumour (4) If any enlarged gland is easily accessible, a biopsy should be performed, as the pathological data obtained may often clinch the diagnosis (5) The sputum should be examined by the "Schaudinn" method for malignant cells (6) If an associated lung change is present, a bronchoscopy with bronchoscopic biopsy of any abnormality should be performed (7) Finally, the effect of a small dose of X-ray therapy on the mediastinum must be tried Any of these collateral methods may give the diagnosis, but only the radiograph can show to what degree the disease has progressed in the chest

The treatment of malignant mediastinal tumours is by X ray, but it is not the purpose of this book to enter into the details of X-ray therapy otherwise than to indicate that an error in diagnosis may result in X-ray therapy being given in such doses as to kill the patient in twenty-four hours It is a well-established fact that heroic dosage should never be given to any mediastinal tumour before the effect of a small dose has been tried firstly, because the giving of large doses with modern deep X-ray plants to lymphosarcoma, lymphadenoma, neoplasm of thyroid and leukaemias can rapidly produce fatal results, and secondly, because the giving of a small dose for carcinoma of the lung about a week before the heavy dosage is

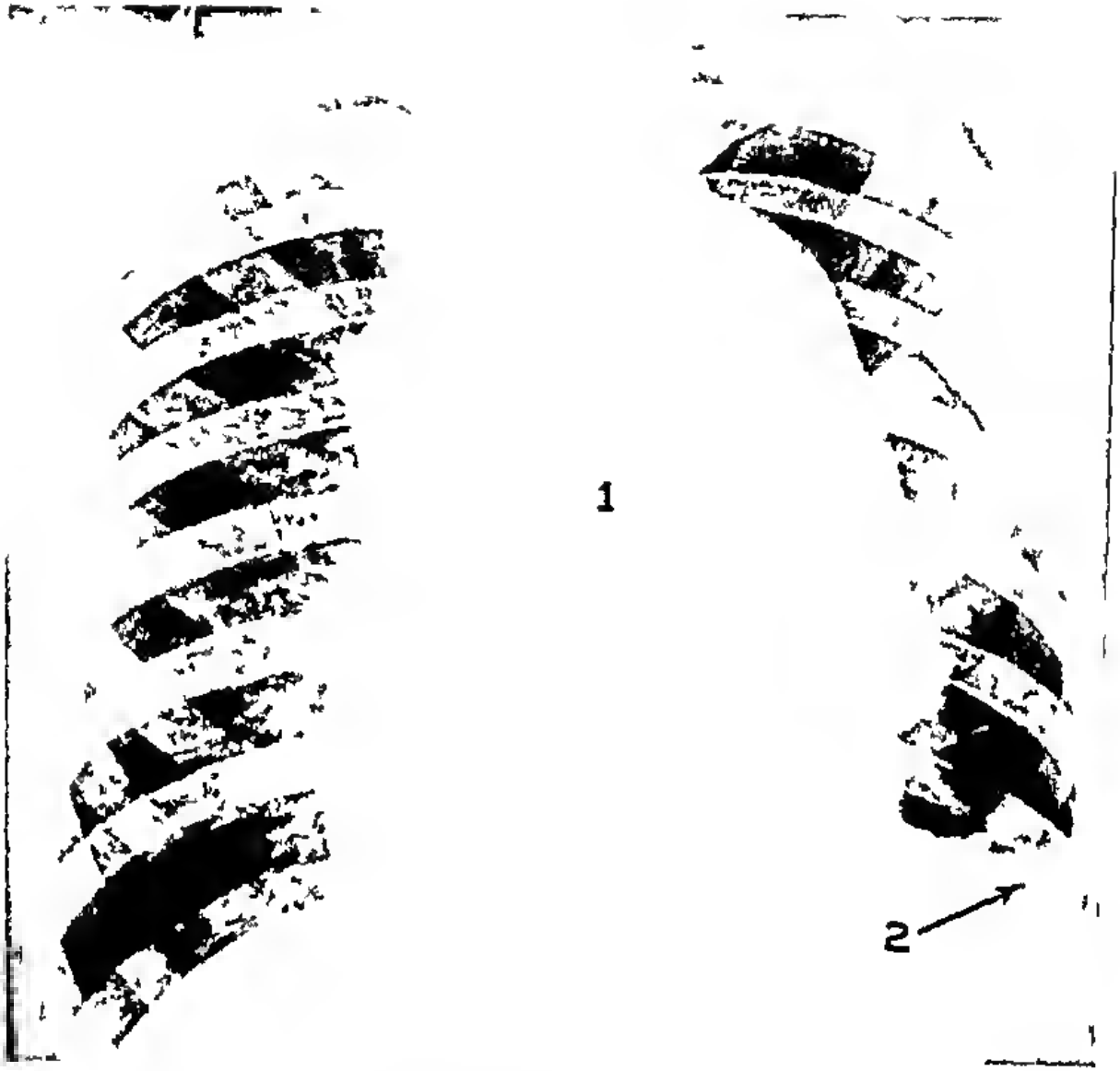


PLATE 184
Generalised Enlarged Mediastinal Shadow
(1) Mediastinal enlargement
(2) Small quantity of fluid
The lung substance on the left side is but poorly seen

commenced, in some way not understood makes possible the giving of heavy doses which could not be tolerated without the primary small dosage

A neoplasm of the mediastinum may be secondary to —

(1) A neoplasm of the oesophagus which will be revealed by X ray examination with opaque fluid of the oesophagus and confirmed by oesophagoscopy

(2) A neoplasm of the bronchus when lipiodol injections of the bronchial tree (see page 170) will show blockage or narrowing, and a bronchoscopal biopsy will give the diagnosis

(3) Neoplasm of the thyroid which shows compression of the trachea (see

PLATE 185

Substernal Thyroid

(1) Intrathoracic thyroid (2) Aortic notch

Intrathoracic goitre, q v) in a typical manner In this case, excessive X-ray therapy will easily kill the patient from thyroid toxaemia

(4) Neoplasm of the thymus This is seen usually in children as an opacity lying between the sternum and trachea (see Plate 186) These tumours are very sensitive to X rays , only very small doses should be given Heavy dosage may produce the rapid appearance of an acute lymphatic leukaemia and death of the patient, though the thymic neoplasm disappears

(5) Hodgkin's disease It is always associated with enlarged glands in the neck or the history that the patient has had enlarged glands which have subsided A biopsy of any gland will give the diagnosis These patients often under X-ray therapy given in small doses, live comfortable and often useful lives for several years If too heavy irradiation is given the patients die rapidly

(6) Lymphosarcoma can only be satisfactorily diagnosed by biopsy of an enlarged gland Here again though they respond well to small doses of deep X ray excessive dosage may be rapidly fatal

(7) In lymphatic or myeloid leukaemia, the blood picture is diagnostic Small doses of X ray alone can be tolerated by the patient The progress and the indication for further dosage can only be controlled by repeated blood examination and radiographs of the mediastinal shadow

(8) The presence of any other primary neoplasm or the history of the removal of carcinoma of the breast, thyroid, or testis is presumptive evidence that the mediastinal growth is secondary Secondaries from breast carcinoma can occur as long as fifteen or more years after the removal of the primary gland Secondaries from teratoma of the testis, on the other hand, usually make their appearance rapidly, though the progress of the disease under irradiation may be checked for two or three years

(9) Neoplasm of the lung The finding of oat cells " in the sputum stained by the ' Schaudinn " method is evidence of neoplasm of the lung Sometimes the mediastinal shadow becomes enlarged before the neoplasm is recognised as originating in the lung Here there is evidence for very heavy X-ray dosage directed on to the affected lung field Many cases are relieved and some return to their normal work for a variable period of from six months to two years, a very few live even longer

There remains a group of benign tumours, all very rare, among which must be included dermoids, fibromata, lipomata, myelomata and also the echinococcus cyst The history of the disease is usually very long and the complete negative evidence of the other lines of investigation alone makes the diagnosis possible Serial films taken at intervals of months show the process to be stationary or only advancing very slowly Treatment is by surgical removal as they do not appear to respond well to X-ray therapy which does at the same time inevitably damage the normal lung tissue

II *Enlargement of the mediastinal shadow restricted to the upper third of the chest*

(A) A substernal thyroid (Plate 185) extends upwards from above the aortic arch as a homogeneous, truncated, triangular-shaped opacity which embraces the trachea There is usually narrowing of the tracheal shadow which has the appearance of an elongated hour-glass and may be deviated to either side

(B) Thymic enlargement in children (Plate 186) The appearance is similar to the above, except that it occurs at an early age and does not cause narrowing of the trachea, which, however, may be displaced

(C) An azygos lobe of the lung (Plate 187) extends sometimes as a homogeneous opacity with a sharp outline to the right of the mediastinal shadow. It is triangular in outline, with its base towards the clavicle and its apex fading into the right hilar shadow. The lobe may often be detected only as a line, the inter-lobar septum, extending from the hilum outwards and upwards to the inner third of the right clavicle. The trachea is not displaced.

(D) An aneurysm of the aorta or innominate artery. It is differentiated from (C) in the above section by demonstrating widening of the aorta in the left lateral position (see under Heart section).

(E) A neoplasm of the upper mediastinum is seen as a generalised homogeneous

PLATE 186
Enlarged Thymus (very marked)

opacity with sharp outline The diagnosis is arrived at by the elimination of (A), (B) and (C)

The outline of the sternum often cannot be seen in the " straight " postero-anterior view of the chest, but if there is rotation the upper segment of the sternum is seen and must not be confused with widening of the mediastinal shadow of the upper third of the chest

III *Enlargement of mediastinal shadow restricted to the hilar gland area* is associated with —

(A) Acute or chronic infective lung changes

(B) Trade lung changes

(C) Enlarged heart shadow The hilar glands are enlarged as a ' back pressure " phenomenon

PLATE 187
Azygos Lobe of Lung Indicated by arrows.

(D) Early tuberculosis of the lung in children before any change may be seen in the lung field

(E) New growths of the hilar glands The shadow is usually smoothly nodular with a hard outline and there may be " fanwise " extension into the lung field The diagnosis is arrived at by the elimination of sections (A) to (D)

IV *Cause of enlargement of the mediastinal shadow restricted to the lower third of the chest*

(A) At the left base by a basal atelectasis of the left lung It is usually only detected in children (Plate 189)

(B) At the right base by an aneurysm of the upper thoracic and abdominal aorta

A lateral picture of the spine may show erosion of the lower dorsal vertebrae (Plate 129; see also Erosion of Vertebrae and Heart section).

(C) At either base in a pleural mediastinitis homogeneous opacity, and are triangular in shape through the heart shadow. All the above shadows are of On the left side they are seen

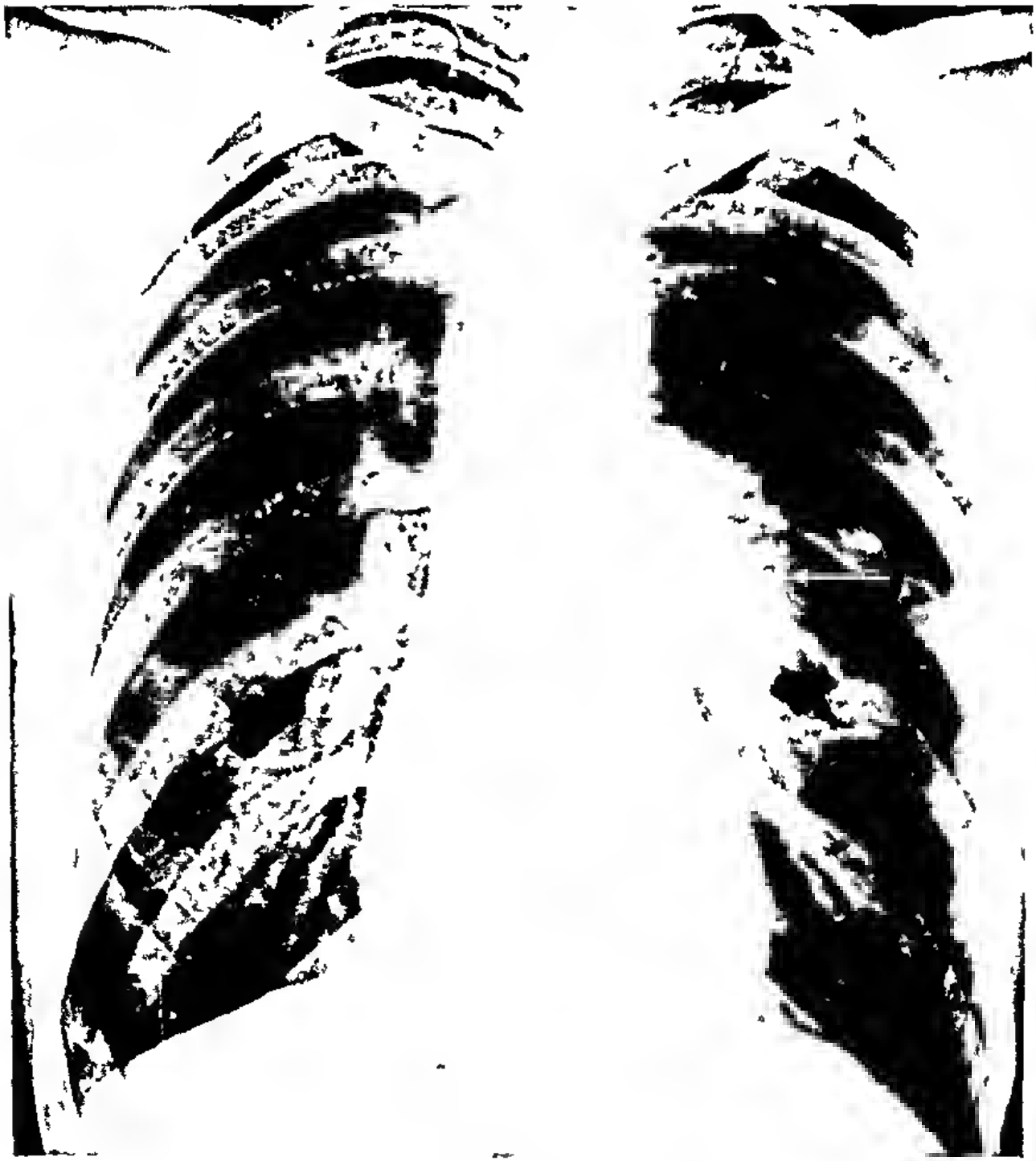


PLATE 188
Neoplasm of Hilar Gland.

The differential diagnosis of (A) (B) and (C) depend often on the history and collateral evidence as radiographic resemblance may be very close

(D) At the left base an oval non homogeneous opacity containing sometimes a gas shadow is caused by a small diaphragmatic hernia (see Examination of stomach for diaphragmatic hernia page 165)

(E) A tuberculous pervertebral abscess in the lower dorsal region may produce a shadow which is seen beyond the right border of the heart or through the heart shadow on the left side The diagnosis is established by antero-posterior and lateral radiographs of the spine which will show typical tuberculous disease of the spine

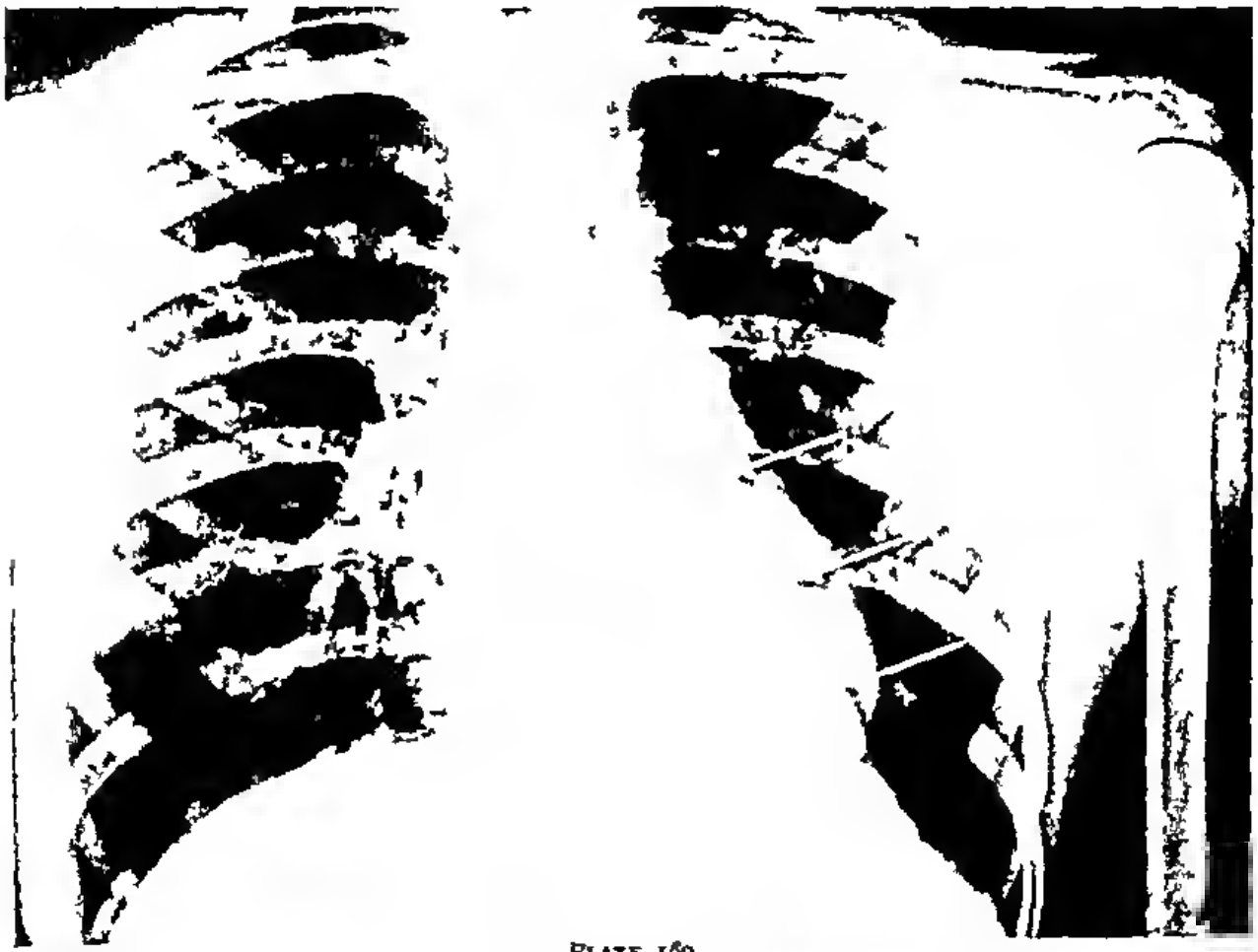


PLATE 169
Atelectasis of Left Lung behind heart shadow
Indicated by arrows

THE DIAPHRAGM

The normal diaphragm is seen as two cupolas separating the chest from the abdomen The right cupola is often higher than the left and may appear to consist of two half cupolas Below them on the right of the abdomen is the liver which is of homogeneous density and below them on the left and towards the centre is often seen the half moon shaped gas bubble on the stomach Its size depends on the gas distension of the stomach External to it is often seen an irregular gas space produced by the splenic flexure of the colon Usually the spleen cannot be seen

SCREEN EXAMINATION

On radioscopy, both sides of the diaphragm are seen to move equally on inspiration; the cupolas are flattened as the ribs expand.

CAUSES OF DECREASED MOVEMENT OF THE DIAPHRAGM

I. Bilateral.

(A) Acute infective lung lesions :—

(*a*) Active tuberculosis;
(*b*) pneumonia;
(*c*) acute bronchitis;
(*d*) pleurisy.

(B) Acute disease of the abdominal viscera, especially marked in acute peritonitis.

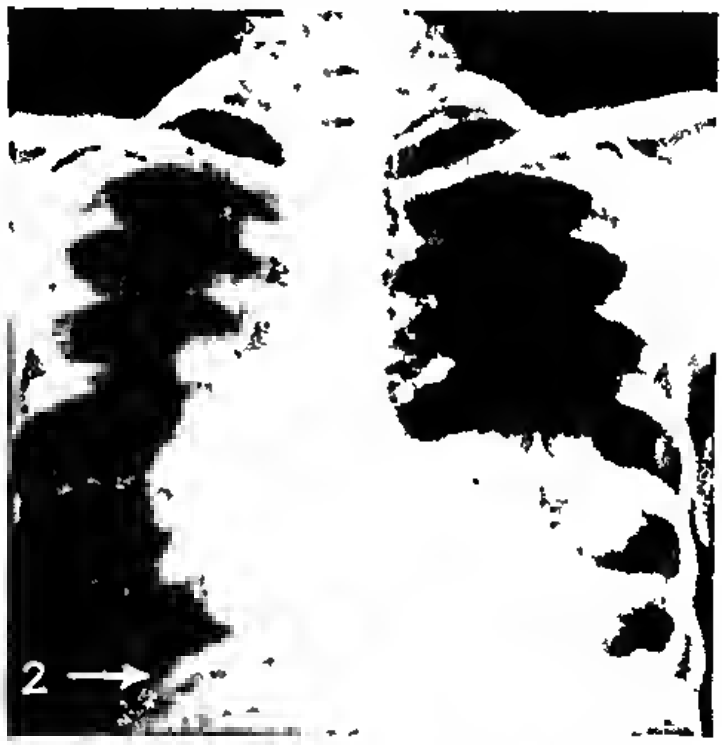


PLATE 190
Paralysis of Left Diaphragm. Note its high position
(1) Left diaphragm (2) Right diaphragm

II Unilateral. The diaphragm shadow is raised on one side only by :—

(A) An acute infective lung lesion restricted to one lung.

(B) An adherent fibroid lung above the diaphragm; the cupola usually shows adhesions pointing upwards toward the lung.

(C) A subphrenic abscess, usually on the right side. (See under Subphrenic abscess).

(D) Pneumothorax. The collapsed lung is easily recognised.

CAUSES OF PARALYSIS OF ONE SIDE OF THE DIAPHRAGM (Plate 190)

(*a*) Following phrenic avulsion.

(*b*) When the phrenic nerve is involved by a tumour, most often at the hilum of

the lung. It is often seen as a change secondary to carcinoma of the oesophagus or breast, with hilar gland involvement.

(c) Relaxatio diaphragmatica. In this so-called idiopathic condition there is no obvious cause, but there may be a past history of diphtheria, scarlet fever, or anterior poliomyelitis, which have produced permanent paralysis of the phrenic nerve.

HERNIA THROUGH THE DIAPHRAGM
(Plate 191)

Diaphragmatic herniae usually occur on the left side The gut shadow, as a non-homogeneous opacity but with hard outline, is seen above the diaphragm; the degree to which it extends upwards depends on the degree of herniation. The true

PLATE 191
Diaphragmatic Hernia in a Baby. A barium meal was given three hours before. The left side of the chest is occupied by gut shadow (1). The heart (2) and mediastinum are displaced to the right.

PLATE 192.
Diaphragmatic Hernia, gas bubble of stomach lying behind heart.
(1) Left border of heart. (2) Left diaphragm.
(3) Gas bubble of stomach.

nature of the opacity should be investigated by giving a barium meal, when the parts of the gut taking part in the hernia can be detected.

A small diaphragmatic hernia may be obscured by the left side of the heart (see page 163, section D) or seen through its shadow (Plates 192 and 193).

THE DIAPHRAGM IN SUBPHRENIC ABSCESS
(Plate 194)

(1) In subphrenic abscess the diaphragm is raised and immobile, the right side being most commonly affected. If gas is present in an abscess on the right side, the gas is seen below the diaphragm, displacing the liver shadow downwards.

The diagnosis depends, in the absence of gas shadow, on collateral evidence and the demonstration of a raised immobile diaphragm with normal lung tissue above The costophrenic angle often becomes opaque, with a small quantity of fluid, and the base of the lung may later show a slight generalised increase of opacity from pleural involvement

Differential diagnosis.

(1) Bronchopneumonia (for the associated lung changes, see Bronchopneumonia page 141) In this the diaphragm excursion is often not inhibited

(2) Pneumonia (for the lung changes, see Pneumonia, page 179)

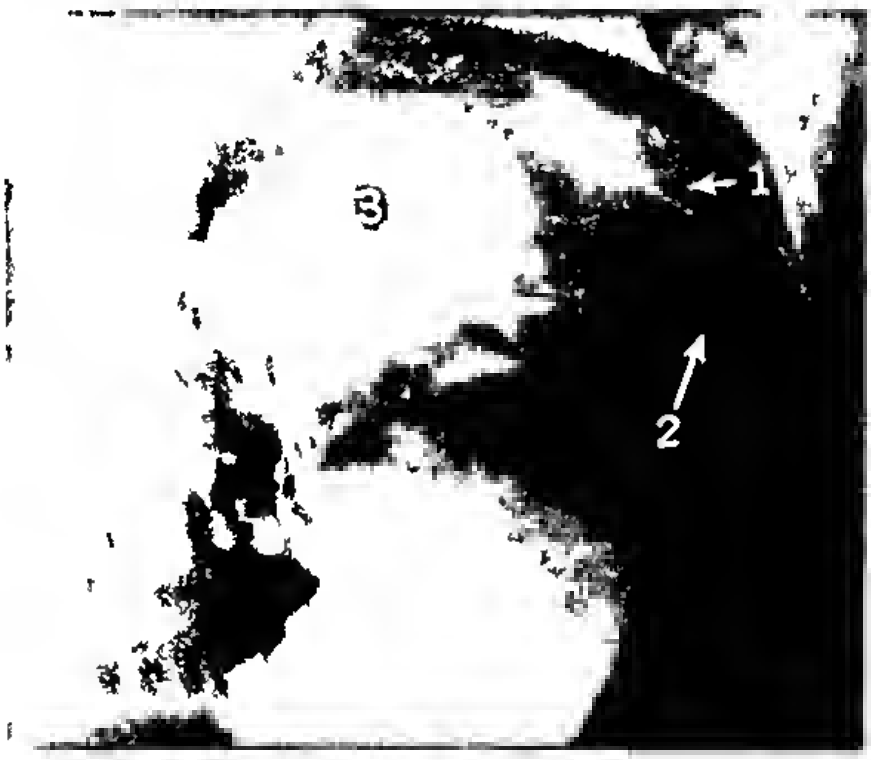


PLATE 193
Diaphragmatic Hernia with barium filled stomach lying behind heart shadow (1) Left border of heart (2) Left diaphragm (3) Hernia above diaphragm

DISEASES OF THE BRONCHI

The normal bronchi are very varied in their opacity, especially in town dwellers where inhalation of carbon particles increases the opacity

The bronchial tree cannot usually be visualised below the bifurcation of the trachea Lipiodol may be used to show up its lumen below the bifurcation

(1) In bronchitis the inner bronchial markings are exaggerated and increased, most markedly at the bases The lung tissue adjacent to the bronchi is more opaque than normal

(2) In bronchiectasis, the bronchial tree shows increased peribronchial opacities and small cavities may be made out at the periphery of the bronchi Where doubt exists, lipiodol must be used to demonstrate the dilatation of the bronchi (see Lipiodol in the lung, page 170)

The cavities are usually cylindrical and in clusters, they are seen on the radiograph as shadows of increased or decreased density, depending on the presence of fluid in the bronchi

(3) New growths of bronchi are difficult to detect unless spread has taken place into the lung tissue They can in the early stages be demonstrated by means of lipiodol, showing (*a*) occlusion, or (*b*) stenosis of a bronchus When partial occlusion of a bronchus produces a localised emphysema in a lobe, this can sometimes be detected by taking one radiograph at full inspiration and a second on full expiration It will be seen that the emphysematous area remains transparent in the radiograph of full expiration, whereas the normal areas become more opaque on expiration At a later stage, when occlusion is complete, collapse of the lung distal to the occluded bronchus occurs (Plate 196) (see Collapse of the lung, page 187)

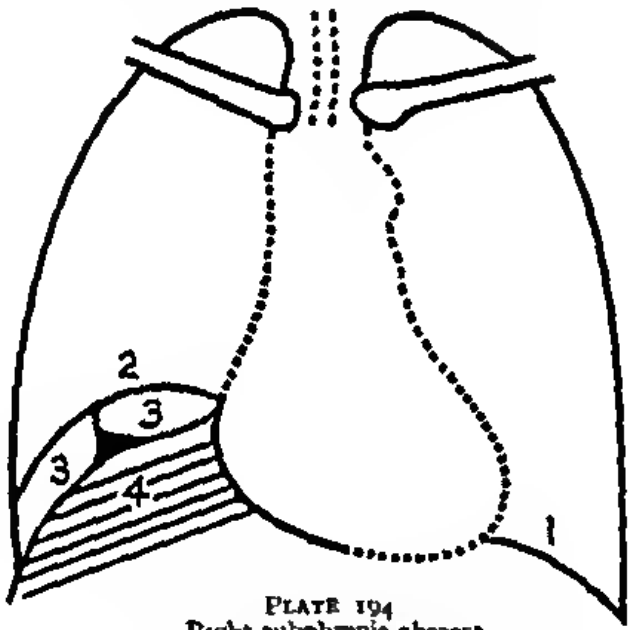


PLATE 194
Right subphrenic abscess
(1) Diaphragm on left side
(2) Diaphragm on right side
(3) Gas between liver and diaphragm
(4) Liver outline.

LUNG TISSUE CHANGES IN DISEASE

A CHANGES IN LUNG TISSUE DENSITY

(1) **Decreased density.** Of peripheral distribution, fading off into the surrounding lung tissue, indicates *emphysema* (page 181) The change is most often basal.

(2) **Increased density.**

(*a*) *A homogeneous opacity* —

(i) A lobar distribution of the opacity with non-opaque costophrenic angle indicates *pneumonic consolidation* (page 179)

(ii) An opaque costophrenic angle with the opacity higher in the axilla than at the hilum indicates *fluid* (page 174)

(iii) A homogeneous opacity in close relation to the hilum not reaching to the chest wall, suggests a *new growth* or *aneurysm*

(iv) An opacity affecting only the peripheral lung fields indicates *thickened pleura* or *encysted fluid*

(*b*) *A non-homogeneous opacity*

(i) An irregular patchy opacity with hilar traction indicates *fibrosis of lung*

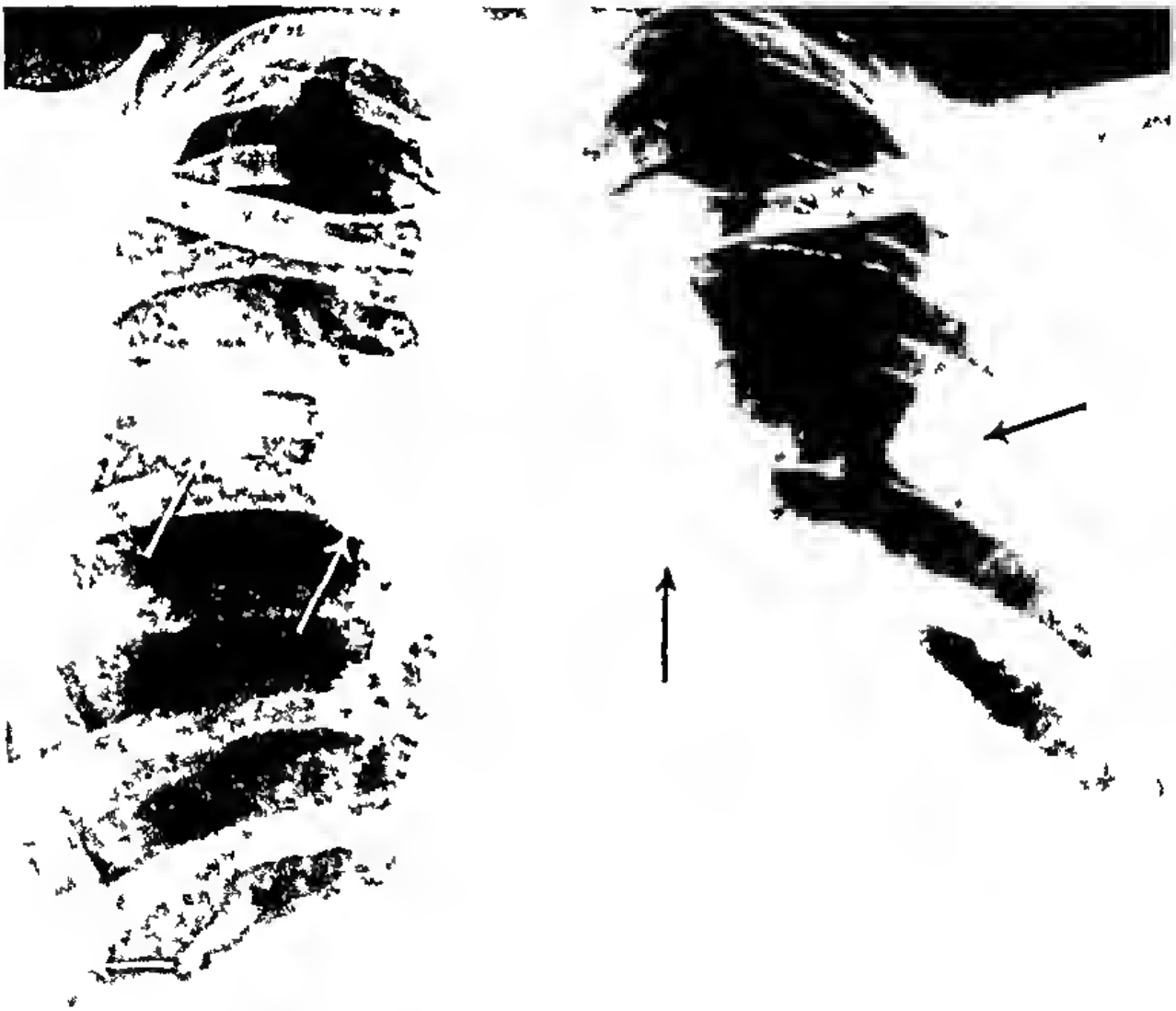


PLATE 195
Secondary Carcinomatous deposit in lung indicated by arrows

PLATE 196

Primary Neoplasm of Lung Note the area of consolidation at the left base The consolidation is not of lobar distribution as would be found in pneumonia

(ii) An opacity homogeneous towards the hilum fading off towards the chest wall of lobar distribution and with no hilar traction, indicates *resolving pneumonic consolidation* (see page 179)

(*d*) *Fine mottled type of opacity, with hard outline*, widespread, but mostly around the hilum suggests *silicosis* (page 186)

(*e*) *Fine mottled type of opacity with soft outline*, mostly peripheral suggests *miliary tuberculosis* (page 184)

(*f*) *Large mottled type of opacity* with cotton wool appearance the centre being homogeneous with hard or feathery outline, suggests *metastatic neoplasm* (Plate 195)

B (1) Small ring type shadow in the lung fields

(*a*) With soft outline suggests *active tuberculosis* (page 184)

(*b*) With hard outline suggests *bronchiectasis* (page 181)

(2) Large ring-shaped shadows in the lung fields

(*a*) Pleural rings though relatively rare are often of perfect ring outline They usually have a wall of equal thickness throughout (see Plate 197)

(*b*) Cavities situated at —

(i) The apex may be single or multiple and are usually tuberculous The walls are irregular in outline and there may be traction of the trachea towards the affected lung The surrounding lung tissue is usually of increased density (page 186)

(ii) The base indicates lung abscess or extensive bronchiectasis They are rarely tuberculous if the apices show no change The walls are denser than in the tuberculous variety, the surrounding lung tissue may be irregularly opaque or almost normal (pages 182)

THE USE OF LIPIODOL IN OUTLINING THE BRONCHIAL TREE

Methods of injection of lipiodol into the bronchus

(1) *By the subglottic route* A curved cannula is passed through the skin and cricothyroid membrane into the trachea

(2) *By the naso-pharyngeal route* A special catheter is passed via one of the nostrils to between the vocal cords

(3) *By the transglottic route* A long cannula is passed over the tongue to between the vocal cords under direct vision by means of a laryngeal mirror

(4) *By intra bronchial injection* by means of a bronchoscope

The first and second methods are the easiest, the third produces the least discomfort to the patient the last is only safe in the hands of an operator skilled in the use of a bronchoscope

The lipiodol must be injected at body temperature and unless proper anaesthesia is used complete failure often results In methods (1) (2) and (3) 2 6 c c of 5 per cent novocaine must be injected into the trachea to diminish the cough reflex

The lipiodol is run into the desired area by gravity

Position of the patient for filling different lung areas

(*a*) *Lower lobe* The patient sits up, inclined towards the side which it is desired to fill 30 40 c c of lipiodol are required

(*b*) *Middle lobe* The patient lies on the side which is to be filled, with the chest and pelvis propped up on cushions 10 15 c c of lipiodol are required

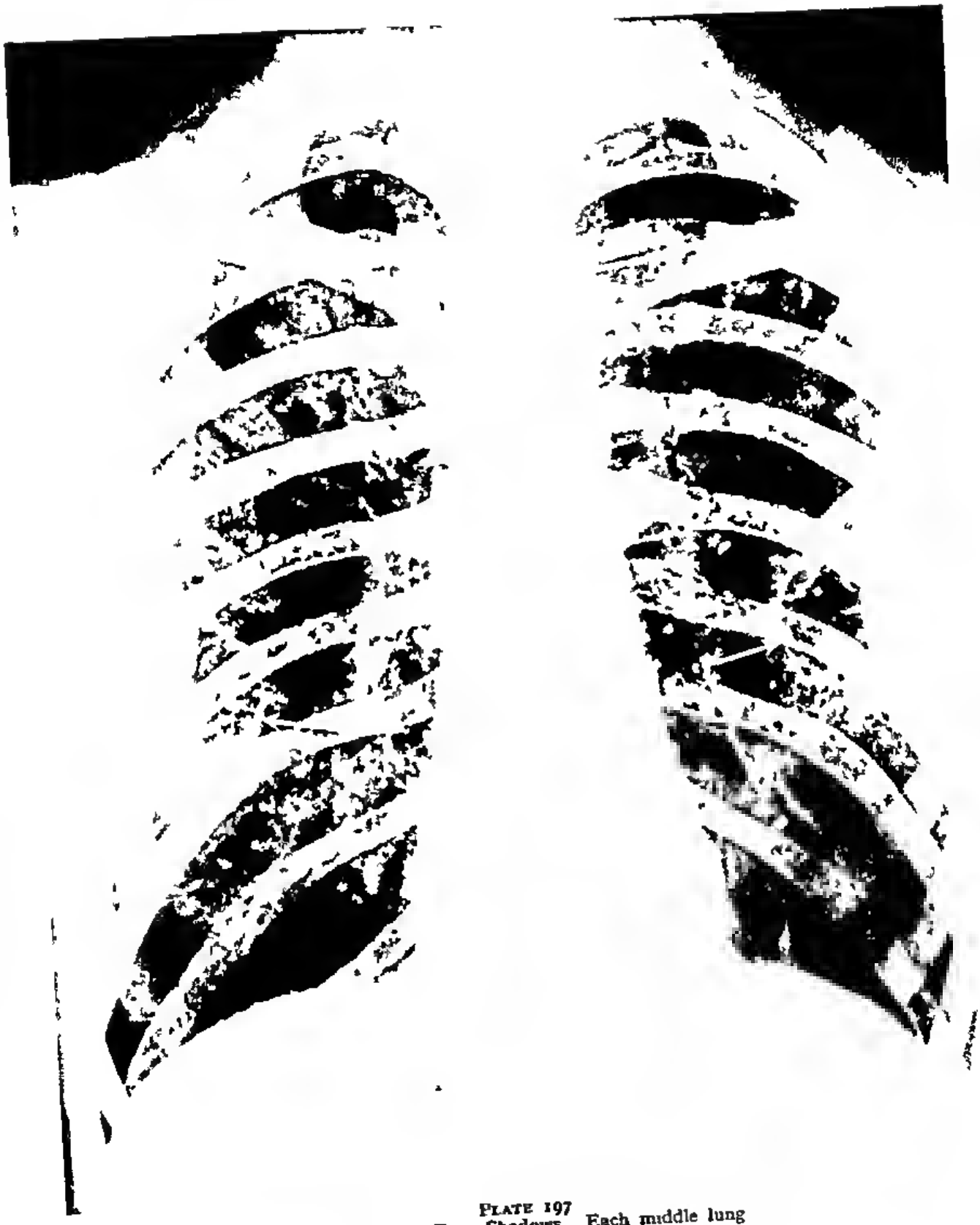


PLATE 197
Large Pleural Ring Shadows Each middle lung zone shows a well formed ring

(c) *Upper lobe* The patient lies on the side to be filled with his arm on that side hanging over the edge of the table

The lipiodol must outline the bronchial tree and not the lung parenchyma If coughing occurs the lipiodol is sprayed all over the lung and the detail is lost Cavities and bronchiectases must be emptied either by coughing or posture, before they can be filled with lipiodol

THE NORMAL BRONCHIAL TREE

The bronchi can be seen at the second and third branchings In the normal the calibre diminishes as the bronchi become more peripheral

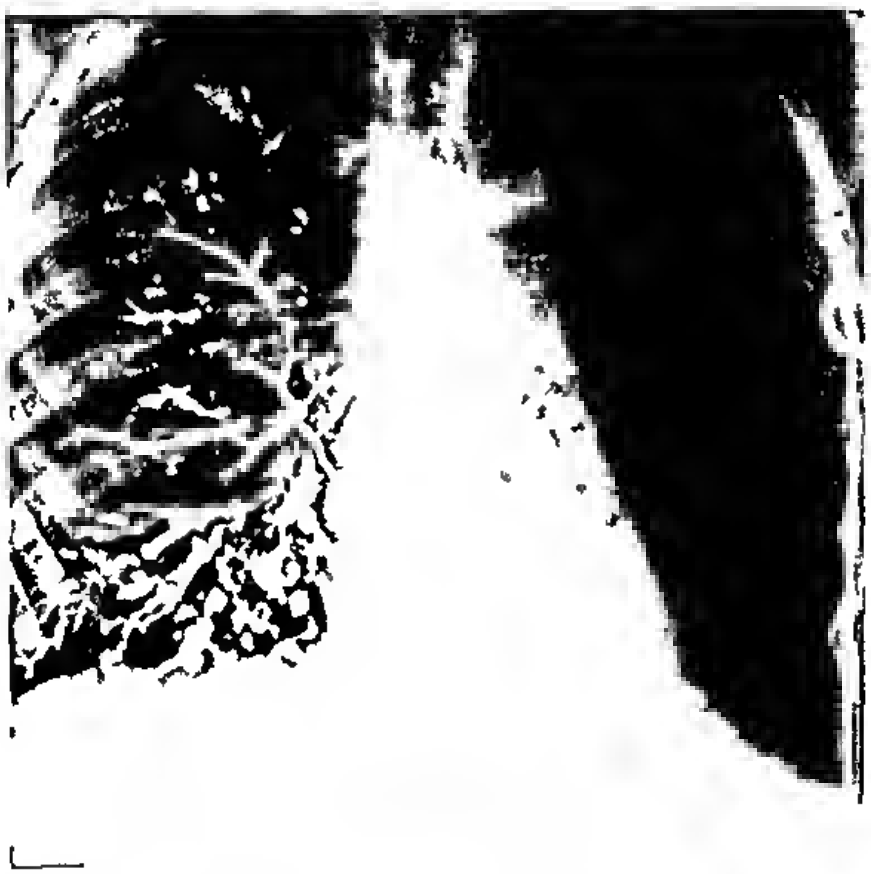


PLATE 198
Bronchiectasis at Base of the Lung filled with Lipiodol *Note* the irregular dilatation of the bronchi behind the heart shadow

Bronchiectasis filled with lipiodol shows (Plate 198) —

(1) The bronchi do not diminish in calibre as they become peripheral
(2) bulb-like dilatation at the periphery
(3) development of multiple cavities which resemble glove fingers

In the *ordinary chest radiograph, bronchiectasis lying behind the heart shadow* can easily escape detection The condition can often only be shown by means of lipiodol

Cavities The relation of the lipiodol filled bronchial tree to cavities is seen The cavities themselves may not be filled with lipiodol if they contain secretion

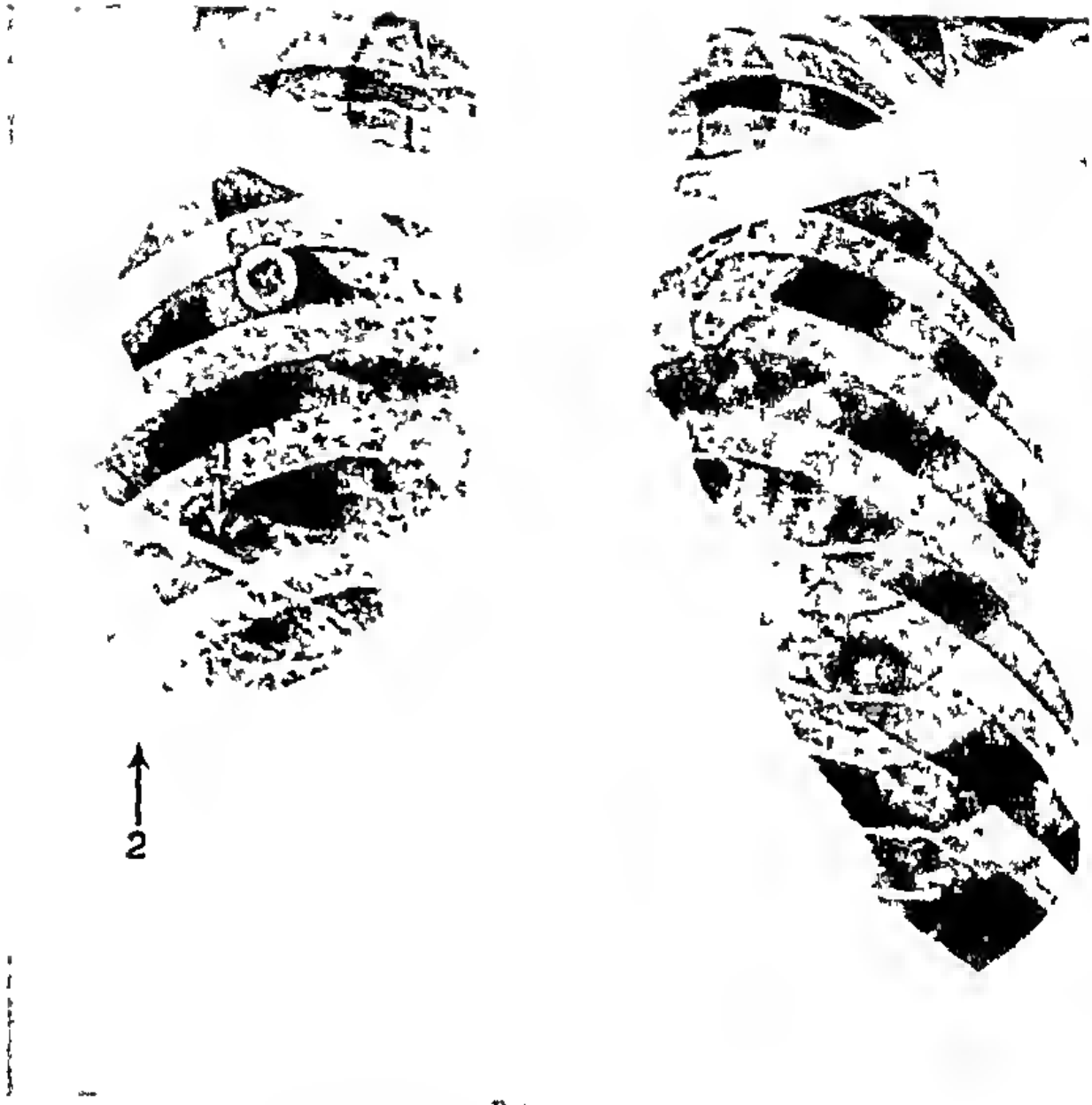


PLATE 199
Interlobar Exudate with Fluid at Right Base
(1) Interlobar exudate
(2) Fluid

Bronchial block. *Bronchi infiltrated with growth show, when filled with lipiodol,* abrupt occlusion The same appearance is seen when a foreign body blocks the bronchus Diagnosis depends on the clinical history of the patient

THE PLEURA

The normal pleura is non-opaque to X-rays and cannot be distinguished from the surrounding tissues In health only a potential space exists between the parietal and pulmonary pleura X-ray changes can only be recognised when abnormal thickness, fluid, or air separate the parietal from the visceral pleura The interlobar pleura can be seen in the normal chest film in some cases on the right side as a faint straight

line crossing the lung field from the hilum This line may appear duplicated from projection

DISEASES OF THE PLEURA

I Acute pleurisy, *per se* shows no X ray changes in the absence of fluid

II Chronic pleurisy of the dry type shows no change unless marked thickening of the pleura is present when the lung tissue is seen to be separated from the ribs along the axilliary border by a homogeneous thick opaque line The lung field appears slightly more opaque on the affected than the non affected side If calcification has

PLATE 200
Fibrin Body in Pneumothorax Cavity

taken place on the pleural surface the lung field shows irregularly scattered and very dense areas of sharp outline

III Fluid in the pleural cavity (Plate 199) With the patient standing in the erect posture the fluid runs to the base and obscures the lower lung field The fluid forms a homogeneous opaque shadow extending from the mediastinal shadow to the costo-phrenic angle and upwards towards the axilla so that the fluid appears to be on a higher level in the axilla than towards the mediastinum and forms an arc with its concavity pointing upwards and inwards Fluid may be encysted when it appears as a dense half lozenge opacity This must be differentiated from sarcomatous change of a rib which may resemble it but shows destructive changes of the rib

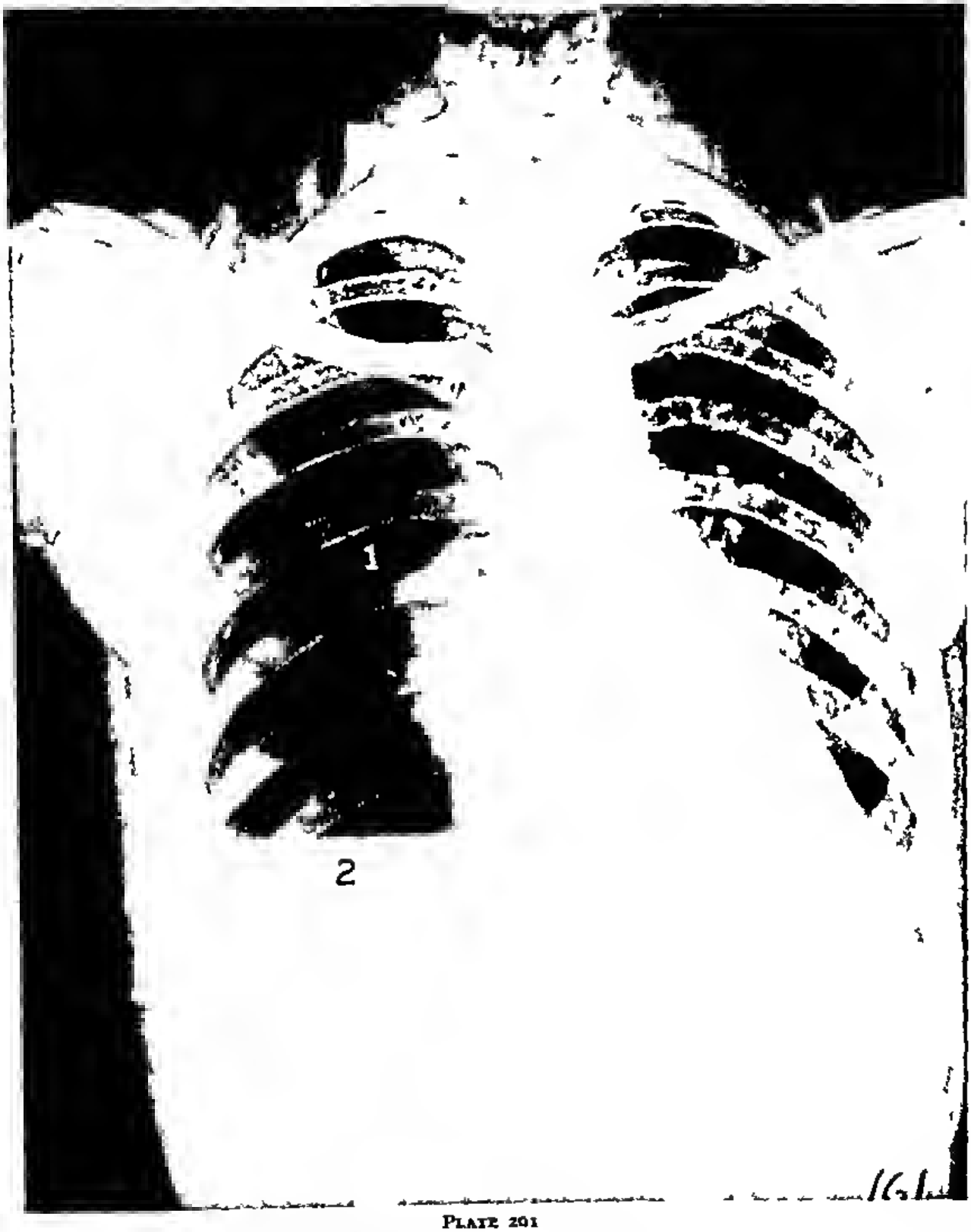


PLATE 201

Hydropneumothorax
(1) Air (2) Fluid (3) Collapsed lung

IV Interlobar fluid (Plate 199) The normal interlobar septum becomes replaced by an opaque homogeneous, spindle-shaped shadow stretching from the hilar shadow to the axilla It is important that a lateral view should be taken to define the position of the interlobar fluid

Differential diagnosis of interlobar fluid

(1) *Encysted pleural effusion* It lies on the chest wall and is detected by screening in the lateral position

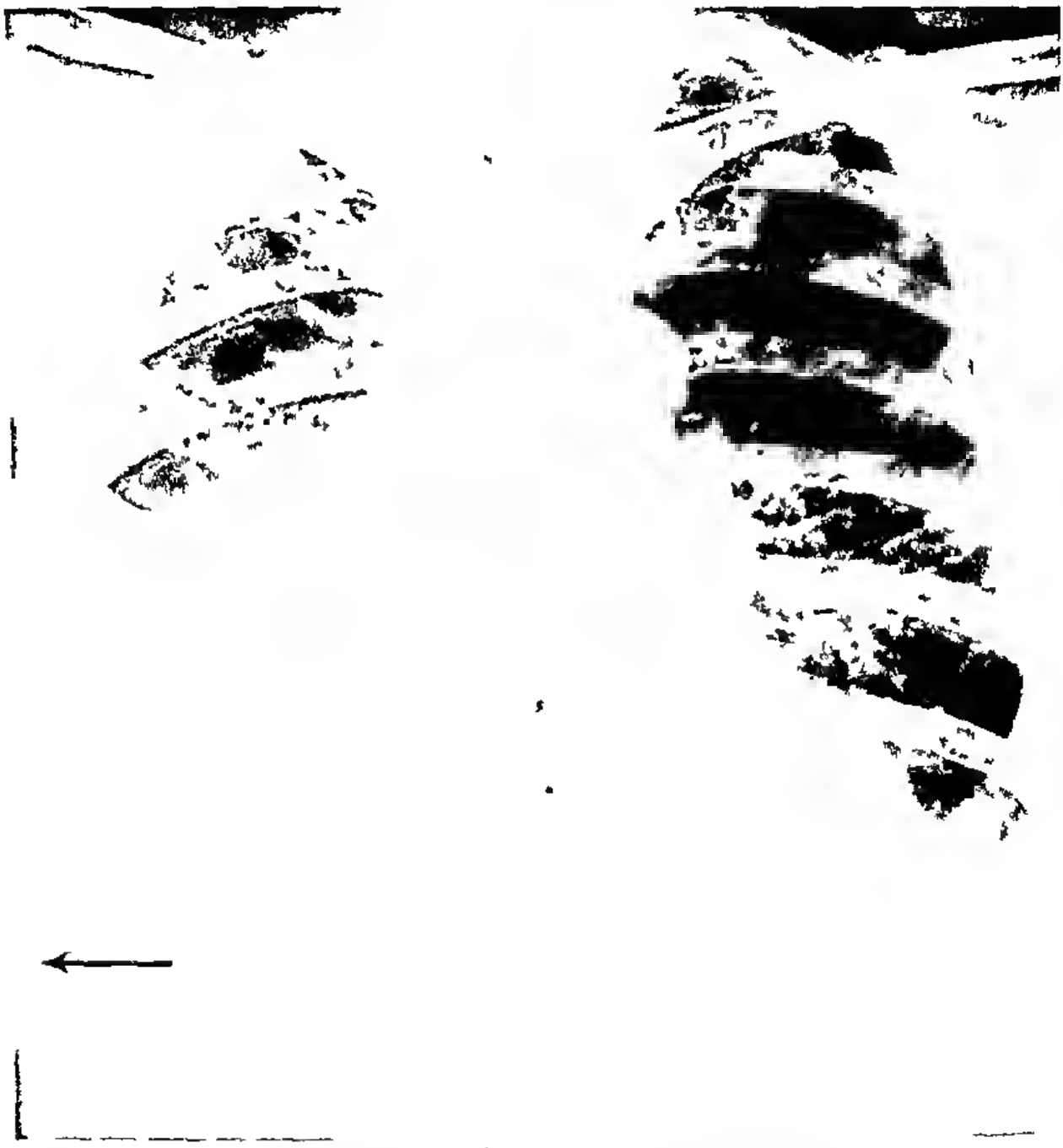


PLATE 202

Pneumonic Consolidation of Lower Left Lobe Note that the phrenicocostal angle indicated by arrow is not opaque as it would be if fluid were present.

(2) *Lung abscess* It is round and not spindle-shaped and does not extend from the axilla to the hilar shadow

PNEUMOTHORAX
(Plate 201)

Air in the pleural cavity causes collapse of the lung which recedes towards the hilum The pleural space is then transparent the collapsed edge of the lung appearing as a hard line limiting the lung shadow In hydropneumothorax, with the patient in

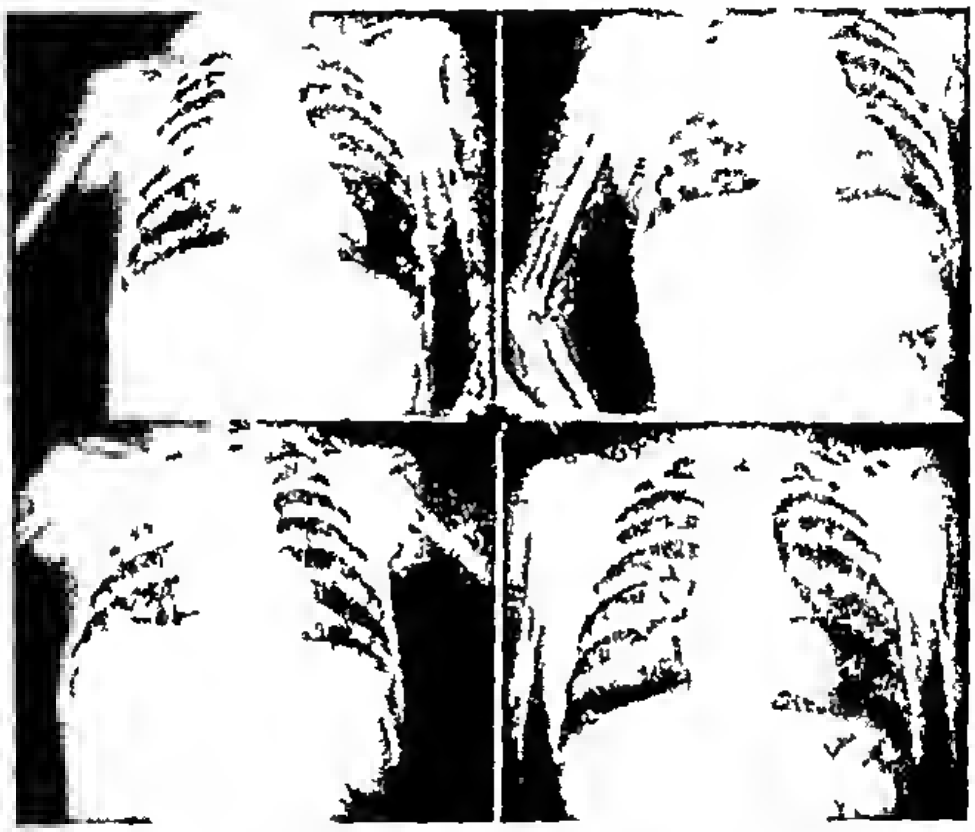


PLATE 203
Pneumonic Consolidation in Lung of a Child
A Middle lobe consolidation B Middle and upper lobe consolidation
C Later stage D Complete resolution

the erect posture the fluid level appears horizontal and dense with the transparent air filled pleural cavity above

The radiographic appearance of a spontaneous pneumothorax and that produced by introducing air into the pleural cavity in a therapeutic pneumothorax are the same The spontaneous pneumothorax is usually small and most often apical Sometimes emphysema of the lung may be seen in the neighbourhood of the spontaneous pneumothorax if the lung is not too collapsed and occasionally a single expanded bulla which has ruptured may be detected Spontaneous pneumothorax is occasionally bilateral

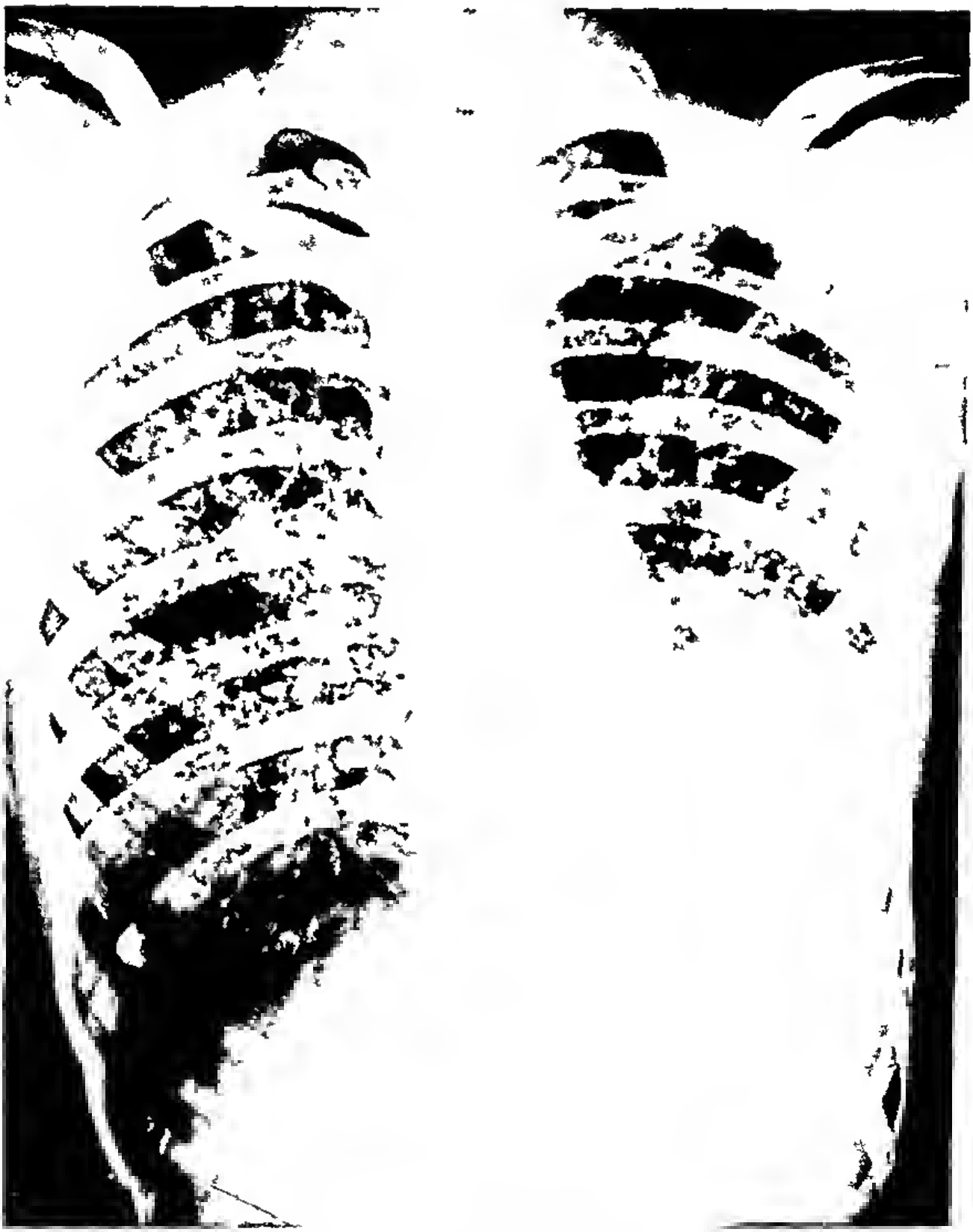


PLATE 204

Acute Bronchopneumonia. The lung field is studded with small soft opacities and small ring shadows. At the left base is an area of consolidation where coalescence has taken place.

The control of a pneumothorax in the treatment of tuberculosis of the lung depends on numerous radiographs or screenings By this means the presence of adhesions to the chest wall is detected, the failure of a cavity to collapse even when the lung is collapsed is seen, and the exact degree of collapse is visualised If an excessive amount of air is put into a pneumothorax, the hilar shadow and the heart will be seen to be deviated towards the normal lung and the patient will suffer respiratory embarrassment

Fibrin bodies Fibrin bodies are sometimes seen in the pneumothorax cavity They are said to be the products of chronic pleurisy which have become separated from the pleura and undergone calcification They have been proved histologically to be composed of layers of fibrin A similar appearance has been said to be produced by small haemorrhages produced by the pneumothorax needle

These bodies form calcified opacities with circular hard outline In density they are often more opaque than the collapsed lung They are most frequently seen resting on the diaphragm but may lie free in the pleural cavity (Plate 200)

PNEUMONIA

(Plates 202 and 203)

Lung changes In pneumonia 1 A homogeneous opacity of lobar distribution spreading from the hilum towards the chest wall showing greater density towards the hilum than peripherally When one lobe only is affected there is a sharp line of demarcation at the interlobar space between the affected and unaffected lobes When resolution takes place, the shadow becomes slightly mottled The middle zone of the opacity sometimes resolves first, leaving the hilar and lateral shadows persistent for some time

2 The hilar glands are enlarged
3 The diaphragm movement is reduced or almost absent
4 The costo-phrenic angle is not opaque unless some fluid is present

Differential diagnosis.

(1) *Pleural effusion* —
- (*a*) The costo-phrenic angle is opaque
- (*b*) The mediastinum may be displaced
- (*c*) Extreme density at the base, with a concave fluid level pointing upwards and inwards
- (*d*) Not confined to lobar distribution

(2) *Collapse of the lung* (page 187)

BRONCHOPNEUMONIA

Acute bronchopneumonia (Plate 204) is an inflammatory process spreading down the bronchi into the alveoli

(1) The hilar shadows are increased mostly on the affected side if the disease is unilateral

(2) Small areas of increased opacity, ring shaped with *soft outline* lie along the course of the larger bronchi stretching out fanwise and usually most marked in the basal areas Apical change is rare in acute non tuberculous bronchopneumonia

(3) The opacities rarely extend as far as the pleural layer laterally

Diaphragmatic movements are decreased

PLATE 205

Chronic Bronchopneumonia The same case as 204 six months later The lung opacities are harder and the small *ring* shadows larger The right base is opaque

Chronic bronchitis

(1) The peribronchial markings are increased especially at the hilum

(2) Small ring type opacities with *hard outline* are seen spreading out fanwise from the affected bronchial areas They are usually basal

(3) Diaphragm movements are normal or sometimes increased except where fibrosis has occurred when the diaphragm is pulled up towards the affected bronchial area

Emphysema (Plate 206)

Emphysema is seen as an area of increased translucency usually at the bases in

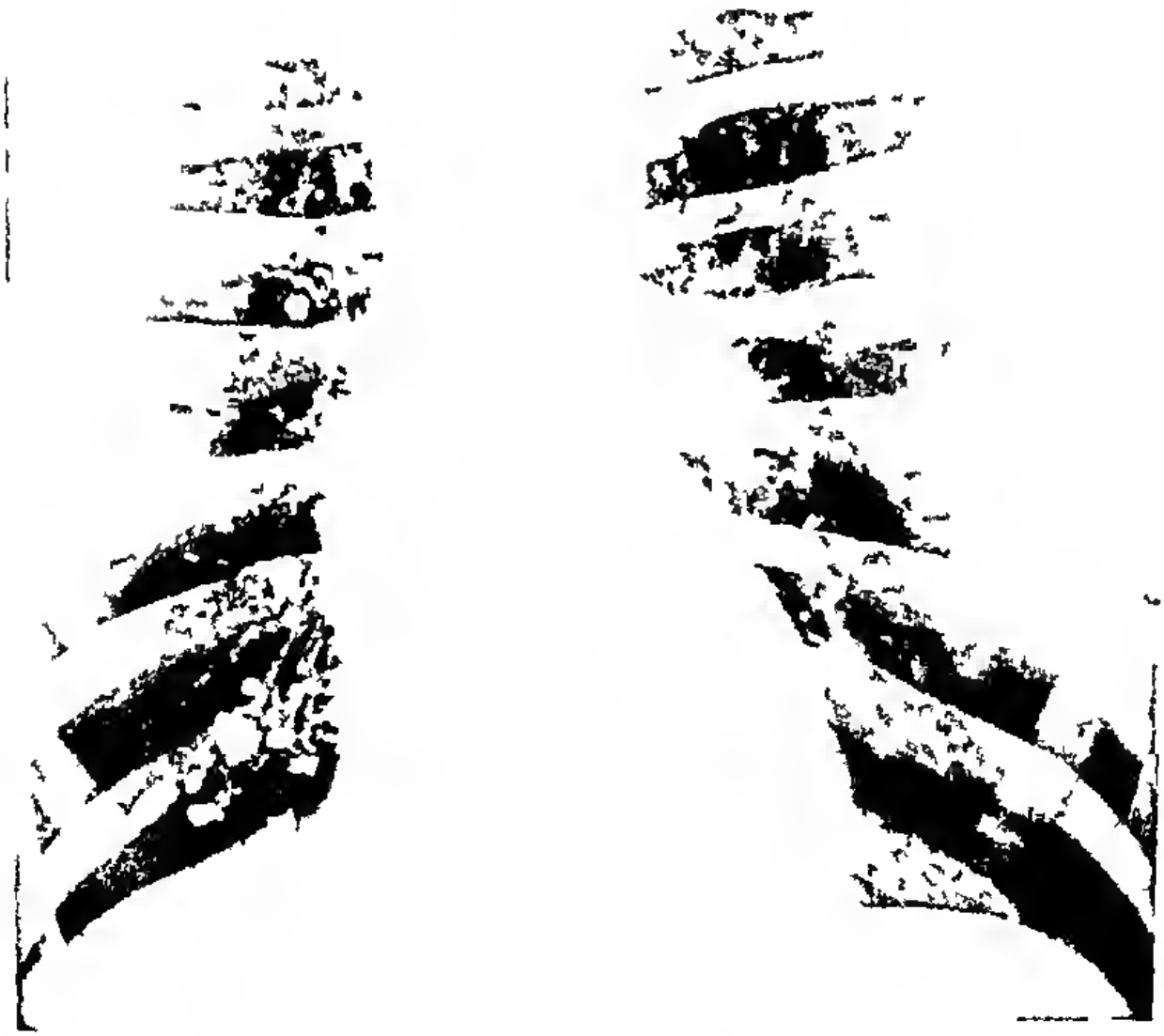


PLATE 206

Emphysema The right base is translucent and shows no lung substance. The bronchi are dilated and filled with iodol

which lung tissue may hardly be discernible. The chest is barrel-shaped and the ribs of the affected side are wider apart if the condition is unilateral.

When only a slight degree of emphysema exists, the increased translucency can often be made out in a radiograph taken in full expiration Where doubt exists, two films must be taken, one at full expiration and a second at full inspiration. The density of the emphysematous areas will be unaltered in either film, whereas the normal lung tissue will appear more dense from the expulsion of air in the full expiration radiograph. The dilatation of the bronchi in the emphysematous area can easily be demonstrated with *lipiodol* injection of the affected lobe.

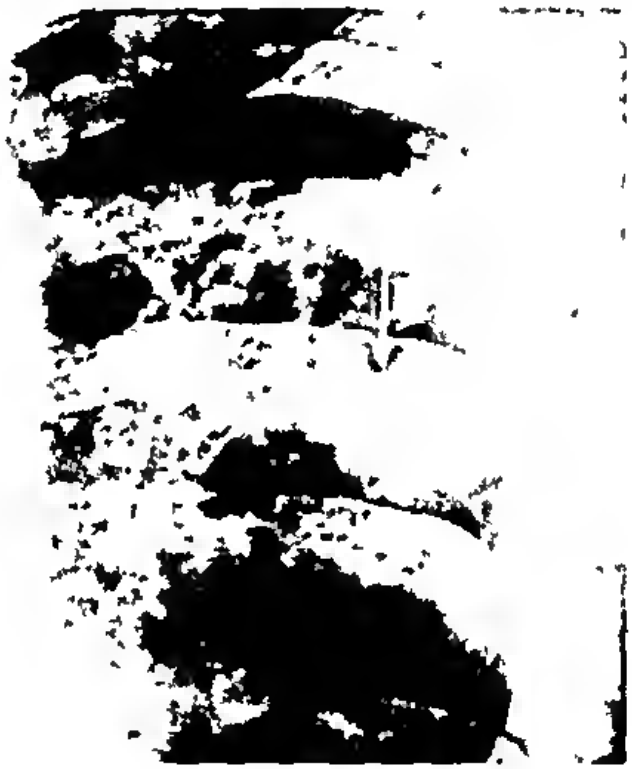


PLATE 207
Lung Abscess with Fluid Level Indicated by arrows.

LUNG ABSCESS
(Plate 207)

The formation of a lung abscess follows most often on acute infective disease of the lung or from the inspiration of infective material.

(1) The position is usually in the mid or basal zone.
(2) The hilar shadow on the side of the lesion is increased.
(3) The abscess is a roughly rounded area of :—
  (*a*) Decreased opacity, if empty of fluid ;
  (*b*) homogeneous increased opacity, if full ;
  (*c*) showing a fluid level if partly filled.
(4) The wall of the abscess cavity is a zone of increased density, with sharp outline centrally if empty, and fading off into the lung field peripherally.
(5) The rest of the lung field may show opacities of the acute bronchopneumonic type.

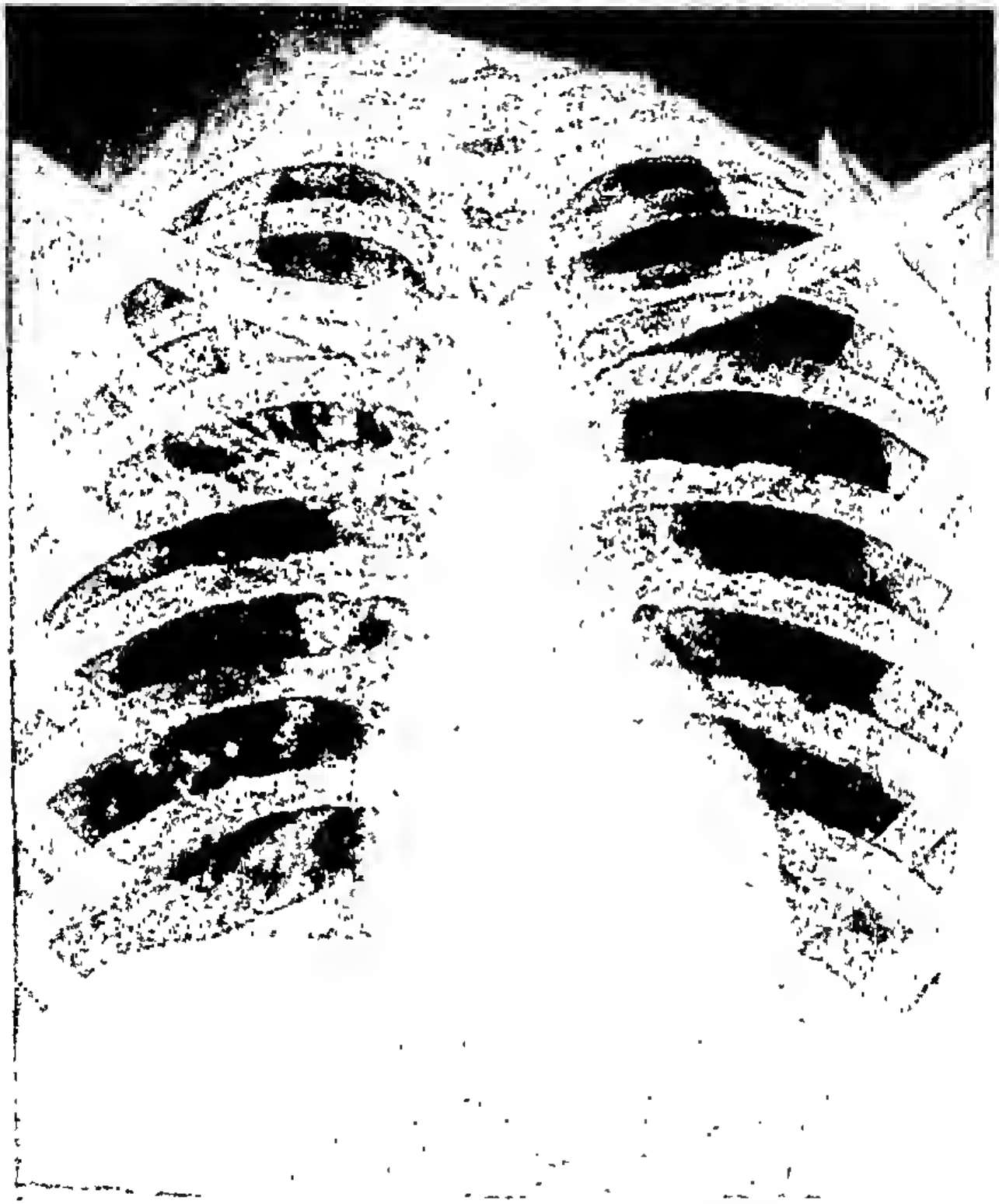


PLATE 208.
Acute active tuberculous infiltration of the right upper zone—acute bronchopneumonic type.

The presence of a lung abscess may be masked radiographically by an extensive pleurel effusion and consolidation of the lung It may be necessary to aspirate the fluid and take several radiographs at intervals of days before the abscess cavity is demonstrated

TUBERCULOSIS OF THE LUNG

Tuberculosis of the lung commences in the walls of the finer bronchi as discrete

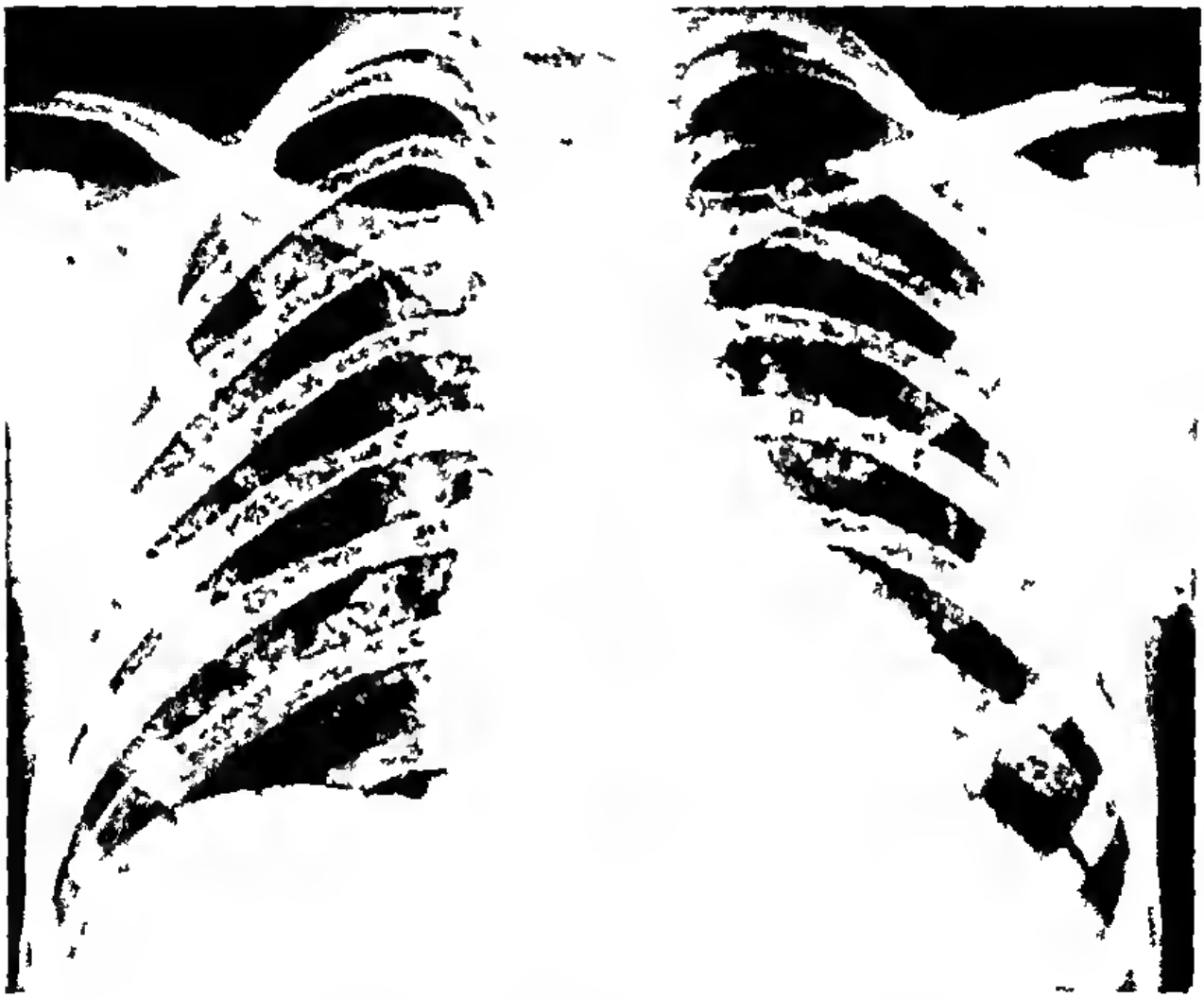


PLATE 209
Miliary Tuberculosis The lung fields are peppered with very small soft opaque spots

areas of bronchopneumonia cavities are produced by the coalescence and breaking down of the numerous infected areas

Tuberculous lesions may be distinguished radiographically as —

(1) *Acute pneumonic type* The appearance is that of pneumonia except that usually as well as the consolidation of a lobe or lobes other lobes show areas of soft mottling of the bronchopneumonic type

(2) *Acute bronchopneumonic type* This shows soft mottling as of acute broncho pneumonia (q v) but the apices and periphery of the lung are affected rather than the basal and hilar areas (*Plate 208*)

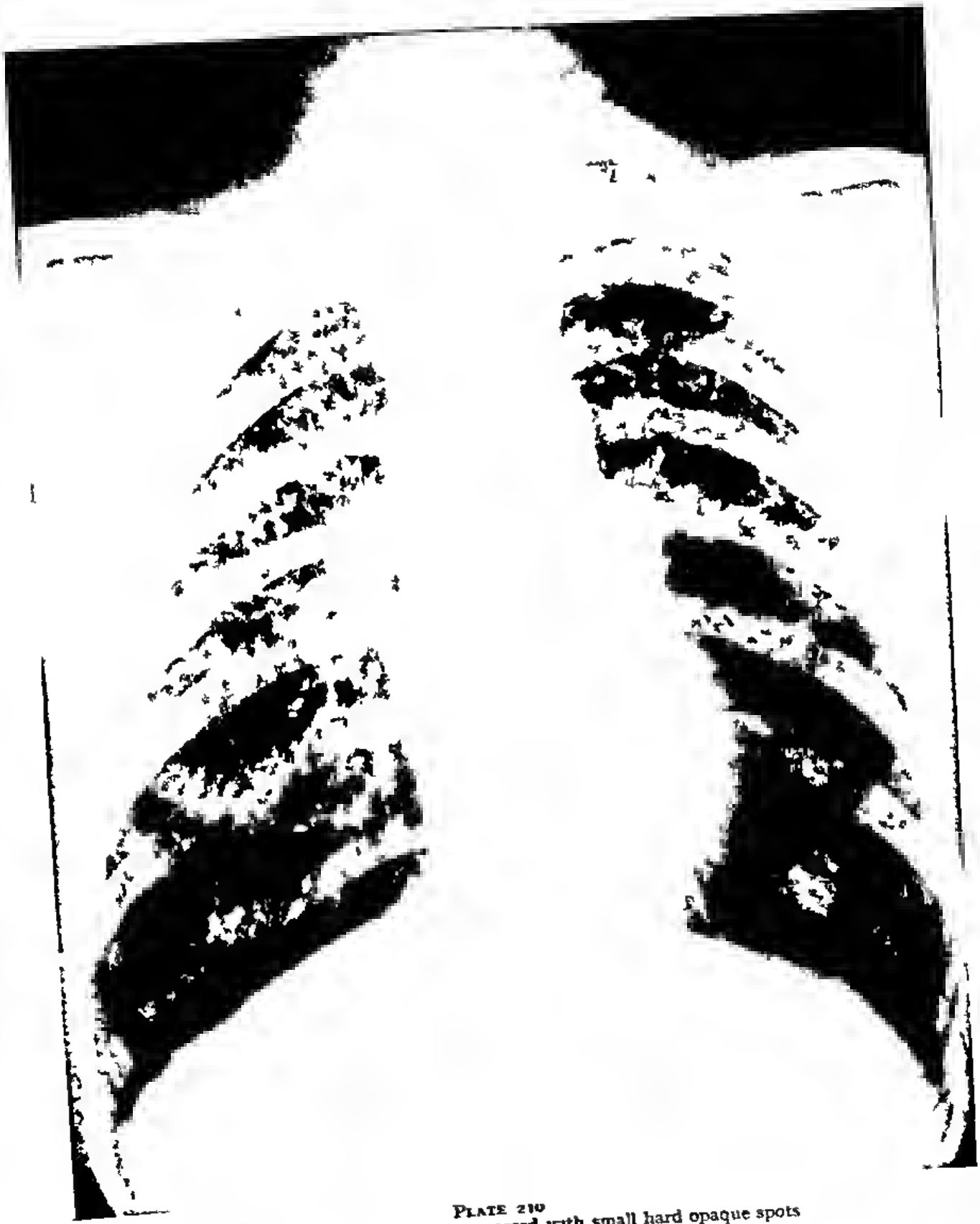


PLATE 210

Silicosis The lung fields are peppered with small hard opaque spots

(3) *Chronic pulmonary tuberculosis* The appearance is typical, there is cavitation usually at the apices, with small areas of bronchopneumonic type of infiltration

(4) *Fibroid tuberculosis* There is obliteration of the lung field by irregular cavities and opacities The hilar shadow and tracheal space will be deviated towards the affected lung

(5) *Acute miliary tuberculosis* (Plate 209) Both lung fields are diffusely peppered, especially at the apices, with small soft " pin head " opacities The film is diagnostic

Differential diagnosis from miliary tuberculosis

Silicosis shows larger, denser and harder shadows

The distribution is more uneven and there are marked variations in size and shape The hilar glands are often very opaque (see page 185)

Neoplastic metastases These may resemble, in children, very closely miliary tuberculosis, but the opacities are usually larger and more discrete, and coalescence does not occur

Influenzal acute bronchopneumonia sometimes produces a radiograph similar to miliary tuberculosis, but the miliary opacities are larger in the case of the influenzal infection

TUBERCULOSIS IN CHILDREN (Plate 209)

1 The adult types, except for miliary tuberculosis, are rare, though they may occur

2 Enlargement of hilar glands alone in children may be evidence of early tuberculosis

It must be emphasised that the diagnosis of tuberculous disease of the lung should not rest on the X-ray appearance alone G T Hebert (London), in his excellent book on ' Pulmonary Tuberculosis," says " X-ray examinations alone should never justify a diagnosis of pulmonary tuberculosis, except perhaps in rare cases of miliary tuberculosis of the lungs The interpretation of shadows depends largely upon the sputum examination and the history of the case "

SILICOSIS (Plate 210)

This disease of the lungs, which is produced by the inhalation of fine dust particles, shows —

(1) The lung field peppered with small hard shadows, usually larger than in miliary tuberculosis unevenly distributed over the lung fields The changes are most marked around the hilar areas

(2) The hilar shadow increased in size and density

(3) Diaphragm movements but little restricted, and adhesions of the diaphragm are usually absent

(4) Patches of emphysema often occur

The differential diagnosis is from miliary tuberculosis (see page 184), but in silicosis the miliary markings are much harder and the lung change is out of proportion with the symptoms as, if miliary tuberculosis were present, the patient would have a swinging temperature and increased pulse rate

Silicosis and tuberculosis of the lung can both co-exist together, the silicosis is said to predispose to tuberculous infection This is of medico-legal importance in some cases

COLLAPSE OF THE LUNG

(1) The collapsed lung has the density of a pneumonic consolidation
(2) There is mediastinal traction towards the affected side
(3) The diaphragm is raised and immobile on the affected side
(4) The intercostal spaces are narrowed on the affected side

Where a lobe alone is affected as from a neoplasm or foreign body blocking a bronchus, the use of lipiodol may be necessary to demonstrate it

Differential diagnosis

(i) *Pneumonia*

(*a*) There is no mediastinal traction

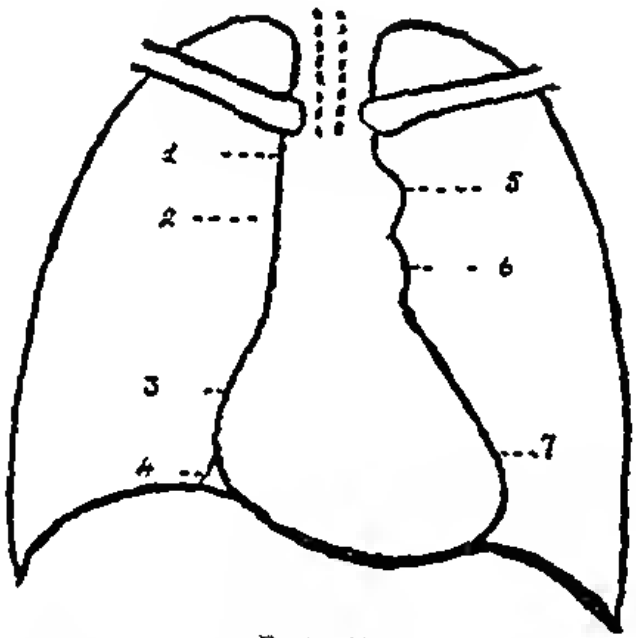


PLATE 211
The Normal Heart Shadow
(1) The superior vena cava
(2) The superior vena cava and right side of aorta
(3) The right auricle
(4) The inferior vena cava
(5) The aortic arch—aortic knuckle
(6) The pulmonary artery and left auricle
(7) The left ventricle

(*b*) The diaphragm is less raised
(*c*) The intercostal spaces are not narrowed
(*d*) The temperature is raised and typical, whereas, in collapse of the lung this is not so (see Pneumonia, page 187)

(ii) *Pleural effusion* Mediastinal displacement is not towards the affected lung but away from it

THE HEART

A radiograph of the heart shadow is a valuable adjunct to the general examination of the cardiac system because, by it, it is possible to see to what degree the various chambers of the heart are enlarged and whether or not the heart is compensated

The heart can revolve round its longitudinal axis in disease, so that the normal accepted relations of the positions of the cavities may become disturbed

The normal heart outline (Plate 211) shows on its right margin from above downwards, the superior vena cava in the upper third, the superior vena cava and right side of the aorta in the middle third, and the right auricle in the lower third In the lowest part of the right side, below the right auricle, the inferior vena cava can sometimes be seen The left margin from above downwards shows three protuberances The highest is produced by the aortic arch—aortic knuckle The next is formed by the pulmonary artery and left auricle and the lowest and largest is the left ventricle

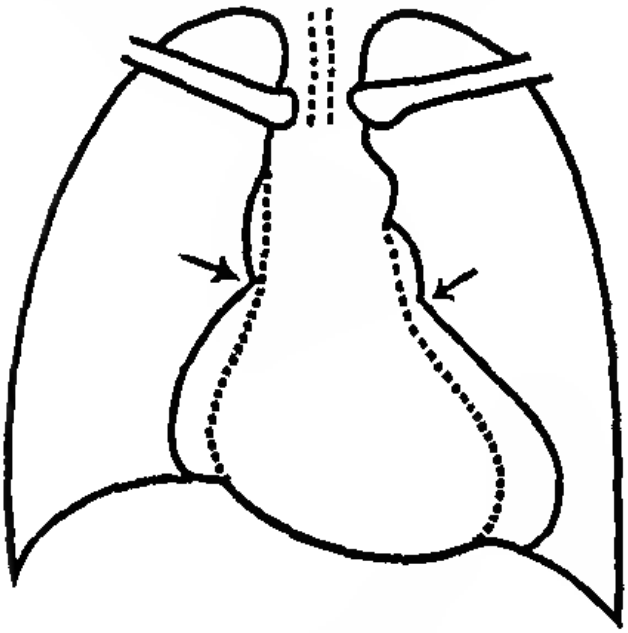


PLATE 212
General Hypertrophy of the Heart

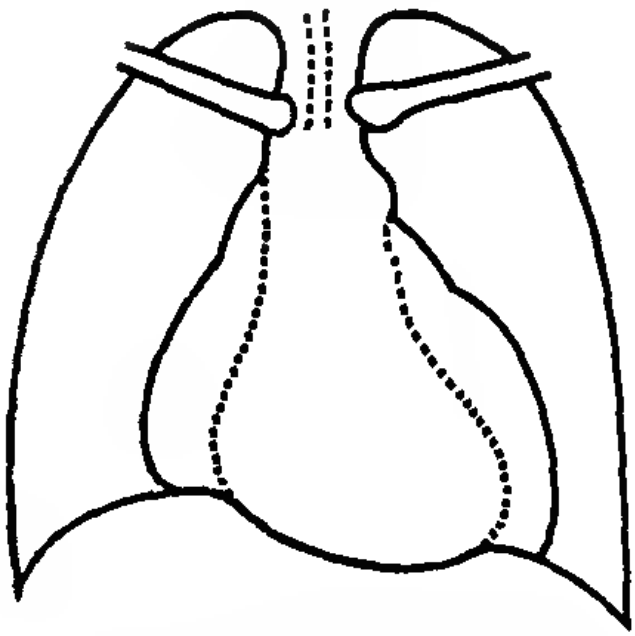


PLATE 213
Myocarditis The outlines of the auricle and ventricle cannot be differentiated

From the following description it is possible to see the commonest changes which occur in the heart shadow in disease

(*a*) General heart hypertrophy. . . Plate 212.

In this the whole heart shadow is enlarged but the relations of the different chamber outlines are not disturbed This change is found in patients with bradycardia It is also seen in the so called " Sport heart " and in those who carry out heavy muscular work In these there is true hypertrophy of the heart muscle

A similar appearance can be produced by a mild degree of generalised dilatation and is found sometimes after infective diseases, pernicious anaemia and fatty degeneration of the heart

(*b*) Myocarditis..... Plate 213

In myocarditis of a fairly advanced degree the whole heart outline becomes more plump The right side of the auricular shadow is enlarged, and the left side of the heart becomes larger as a whole so that the protuberances disappear and the left margin becomes almost a straight line

(*c*) Cor bovinum ..... **Plate 214**

This is an extreme degree of dilatation of the heart It is the largest type of heart shadow seen and is most commonly associated with advanced aortic lesions Both sides of the heart show gross enlargement and the outline becomes flask shaped In pericardial effusion the right side of the heart does not show such a degree of enlargement

(*d*) Hypertrophy of the left ventricle . .Plate 215

The enlargement of the left ventricle gives the heart the shape of a boot This change is seen associated with increased work of the left ventricle in hyperpiesia and mild degrees of aortic stenosis or insufficiency

PLATE 214
Cor Bovinum Note the large size of the heart shadow

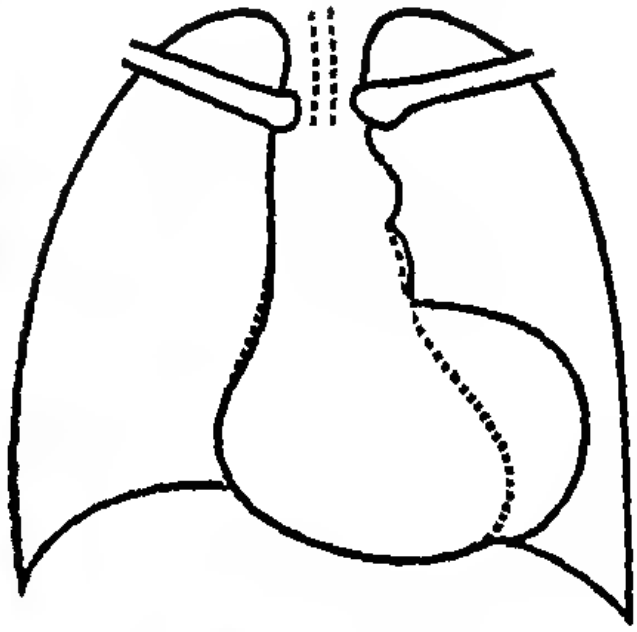


PLATE 215
Hypertrophy of the Left Ventricle

(*e*) Mitral incompetence, heart compensated . .Plate 216

The left auricle and pulmonary artery are enlarged so that they obscure the lower part of the aortic knuckle above and a small part of the left ventricle below The right ventricle also enlarges

(*f*) Mitral incompetence uncompensated . Plate 217

This is a further stage The left auricular protuberance is enlarged and the left ventricle dilates The right auricle enlarges from dilatation of the right ventricle producing tricuspid incompetence

(*g*) Aortic insufficiency, compensated .Plate 218

The heart is boot-shaped from enlargement of the left ventricle The hypertrophy, which takes place, is followed by dilatation which is mild in the compensated stage The left auricle and pulmonary artery are not enlarged

The commonest causes of aortic insufficiency are congenital malformations of the aortic valve, endocarditis of the aortic valve, syphilis of the aorta producing dilatation of the valve and arteriosclerosis of the aortic valve Sometimes an aortic valve may rupture following excessive effort

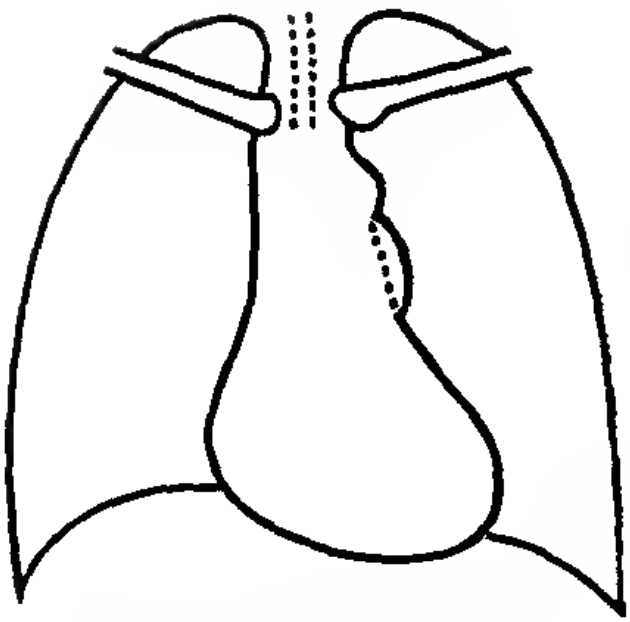


PLATE 216
Mitral Incompetence heart compensated
Hypertrophy of left auricle

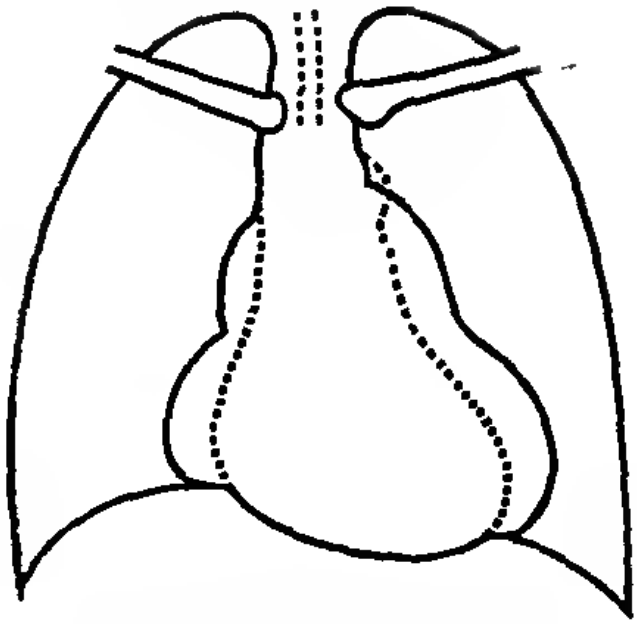


PLATE 217
Mitral Incompetence heart uncompensated
Dilatation of all chambers.

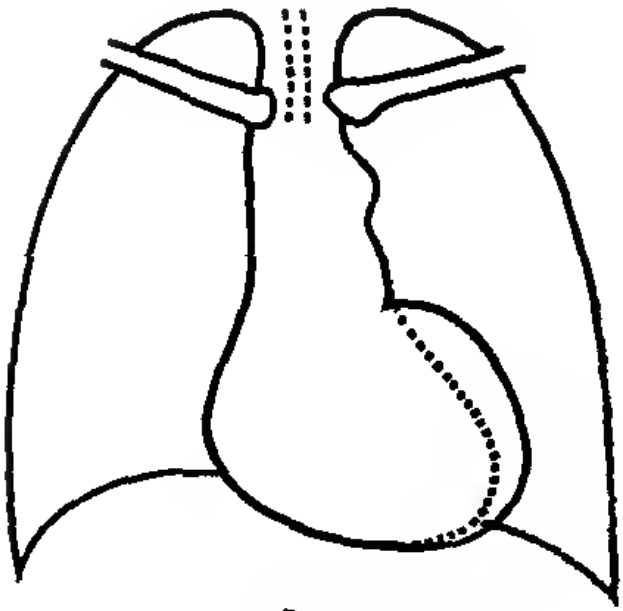


PLATE 218
Aortic Insufficiency compensated

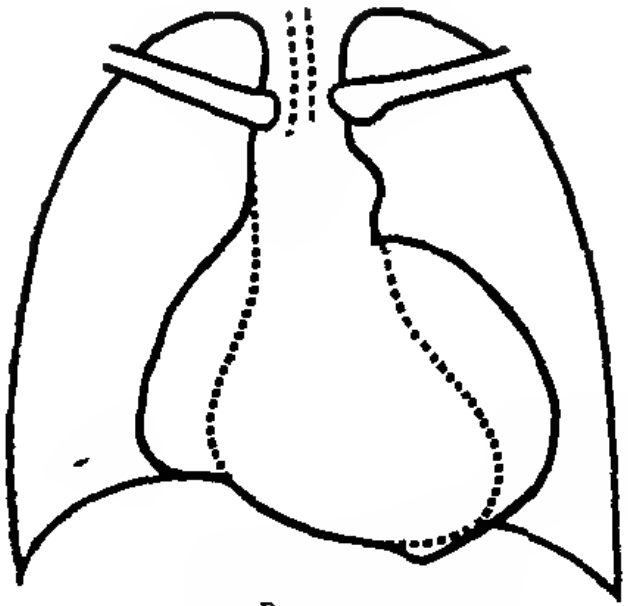


PLATE 219
Aortic Insufficiency uncompensated

(*h*) Aortic insufficiency uncompensated Plate 219

The left ventricle is larger than in the compensated type and may reach almost to the axillary border Dilatation of the left auricle is masked by the ventricular enlargement The right side of the heart shows enlargement The cor bovinum is a still later stage of this lesion

(*i*) Aortic stenosis Plate 220

The left border of the heart tends to be straight The left auricle and ventricle are both enlarged in this stage

(*j*) Aortic and mitral disease Plate 221

This may be due to disease of both the aortic and mitral valves but may also be a later stage of aortic stenosis dilatation of the left ventricle producing mitral insuffi

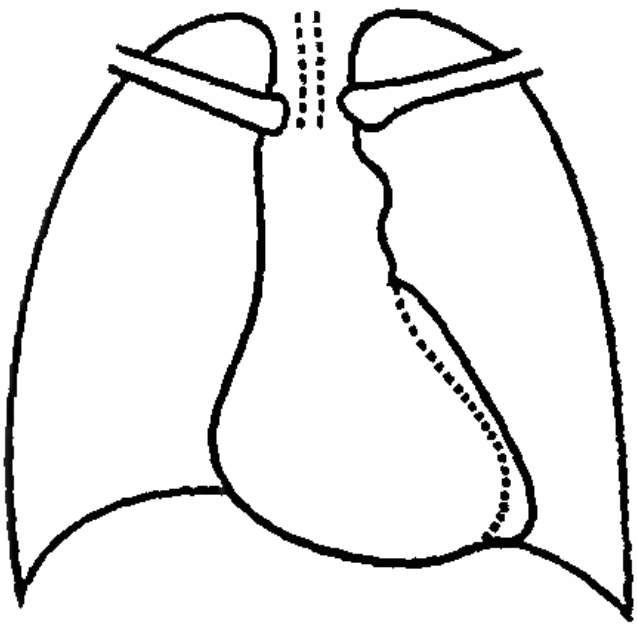


PLATE 220
Aortic Stenosis with Dilatation of Left Ventricle

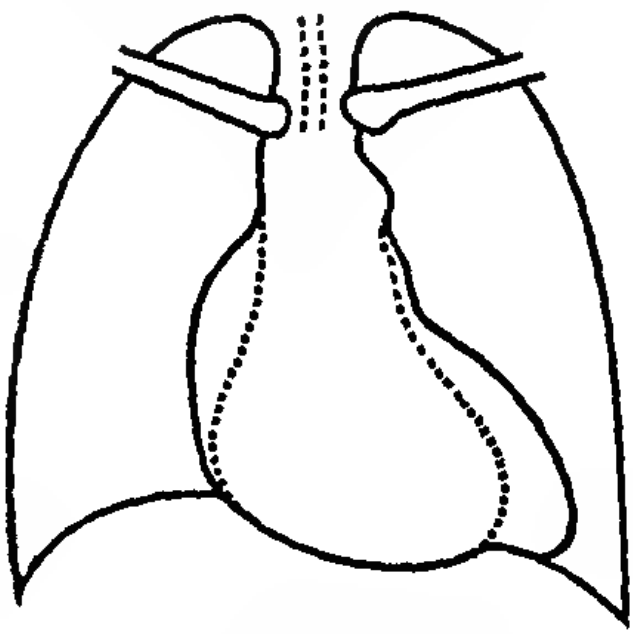


PLATE 221
Aortic and Mitral Disease

ciency The left side of the heart shows enlargement of the left auricle and pulmonary artery in its middle third and enlargement of the left ventricle in the lower third

(*k*) Tricuspid insufficiency Plate 222

In this condition the right auricle is the first to enlarge The right side of the heart dilates and the superior vena cava is seen dilated to the right The increased back pressure of the venous circulation leads to increased strain on the left side of the heart This first hypertrophies and then dilates so that the left side of the heart shadow is enlarged in its auricular and ventricular parts

(*l*) Hydropericardium

In this condition the pericardial sac becomes distended with fluid so that the outline becomes flask shaped The *left* side is *much* larger than the right *in* which respect it differs from the cor bovinum Plate 223 shows a hydropneumopericardium in which the pericardial sac has been infected by B Welchii which has produced gas The upper part of the pericardial sac can be seen to be separated from the heart shadow by gas and fluid separates it below

Measurements of the Heart Shadow

Measurements of the heart shadow are difficult to interpret with accuracy and often unsatisfactory because of the wide variations which occur in the normal They have not been included in the text because they add little to the radiograph, which is valuable only so long as no attempt is made to reduce its meaning to a mathematical formula The great difficulty in obtaining exactly comparable points on the heart shadow, either obtained by an orthodiagram or from a radiograph taken at six feet distance has made most radiologists abandon them

THE AORTA

The aortic arch forms at its summit the *aortic knuckle* which is seen in a postero

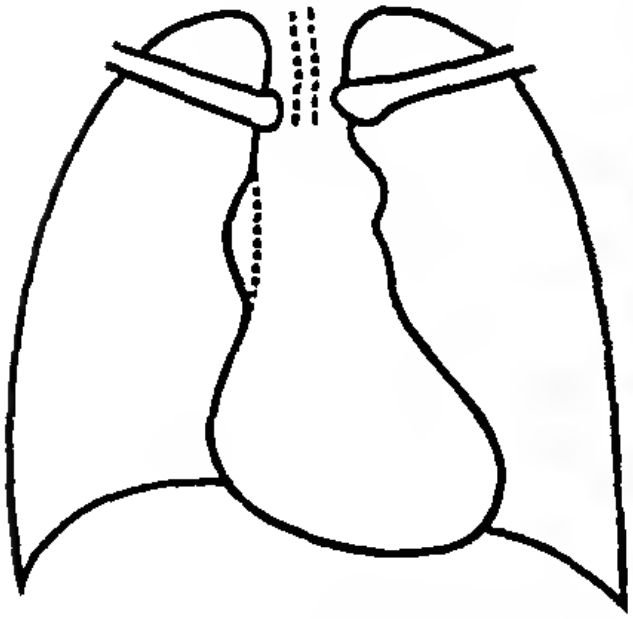


PLATE 222
Tricuspid and Mitral Insufficiency

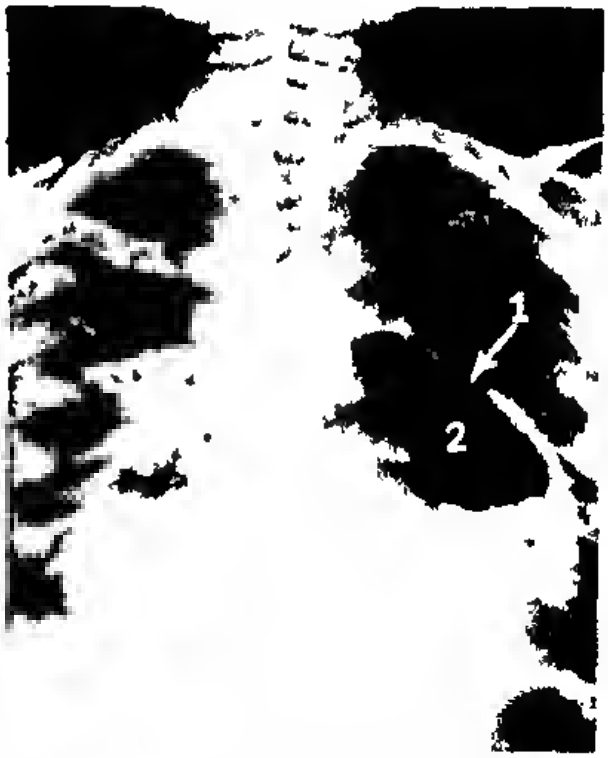


PLATE 223
Hydropneumopericardium following Infection of Mediastinum by B Welchii
(1) Pericardial sac (2) Air in sac (3) Fluid

anterior radiograph of the chest as a well defined shadow on the left of the mediastinal shadow below the clavicle The shadow of the ascending and descending aorta overlie each other and blend with the mediastinal shadow

To measure the dilatation of the aorta, it is necessary to turn the patient half-left so that the aortic arch is seen in profile, the descending aorta falling in the posterior mediastinum (Plate 224) The limit of the aortic measurement radiographed at 2 metres is 1 6 cm , above this limit dilatation is present

ANEURYSM AND AORTIC DILATATION
(Plate 225)

In aortic dilatation, the descending aorta in the postero-anterior view is seen to

extend to the left of the upper part of the heart shadow It may also extend to the right of the heart shadow (see Enlarged Mediastinal shadow page 156) Where enlargement of the mediastinal shadow exists if it is possible to distinguish an aortic shadow of normal dimensions aneurysm may be excluded

The pulsation of an aneurysm cannot always be seen on the radioscopic screen if it is filled with clot no pulsation may take place Aneurysm of the descending thoracic and abdominal aorta if sufficiently large cause erosion of the vertebral bodies from pressure This may be seen in a lateral radiograph of the spine (see Plate 129) It is diagnostic when associated with enlarged mediastinal shadow

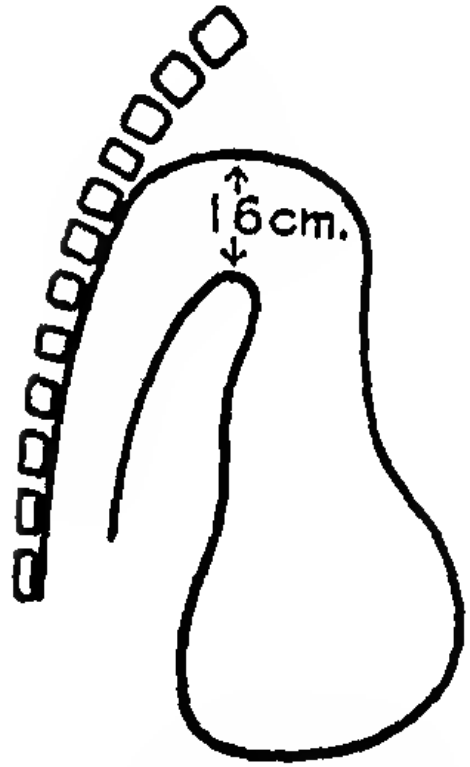


PLATE 224
Normal Aortic Arch as seen when the patient turns half left

PLATE 225
Aneurysm of Aortic Arch Displacing Oesophagus to Right The oesophagus is outlined by opaque fluid and dislocated to the right by the aneurysm *Indicated by arrow*

THE GASTRO-INTESTINAL TRACT AND ABDOMINAL CONTENTS

CHAPTER V

THE ALIMENTARY TRACT

THE OESOPHAGUS

Abnormalities of the oesophagus can only be adequately investigated by screening the patient and outlining the oesophagus with opaque fluid The patient should first be given barium emulsion of the consistency of cream, and if no abnormality is detected, this should be followed by barium emulsion of the consistency of treacle

In the right oblique position, the patient having turned half-left, the oesophagus is clear of the vertebral column behind and the heart shadow in front (Plate 226) The appearance on the screen in normal swallowing of the barium cream (see page 201) is that, on the act of swallowing, a small amount of the material is seen to fall over the back of the tongue, pass through the pharynx—where momentarily some of the fluid outlines the valecula—and then enter the oesophagus A momentary delay at the cardiac orifice occurs before the fluid passes into the stomach Solids, however, do not as a rule show this slight delay

ABNORMAL CONDITIONS

I **In paralysis of the recurrent laryngeal nerve,** from enlargement of the left auricle, aneurysm, or mediastinal growth, the amount of material lying in the valecula is much increased, and instead of being only a fleck, it is seen to persist as a double dark area This may be the earliest evidence of neoplastic enlargement of bronchial glands from paralysis of the left recurrent laryngeal nerve

II **Displacement of the oesophagus.** The examination is made in the postero-anterior and half-lateral positions The normal oesophagus is seen as a narrow tube extending from the lower body of the cricoid cartilage to the cardiac orifice It lies slightly to the left in its upper third, crosses the mid line at the level of the aortic notch, and then lies slightly to the right till just above the diaphragm, when it passes to the cardiac orifice on the left

Causes of displacement of the oesophagus —

(1) In pulmonary fibrosis, the trachea and oesophagus are both displaced towards the lung lesion

(2) In aneurysm of the descending aorta, the oesophagus is displaced to the right.

(3) In mediastinal tumours, the displacement may be in any direction, depending on the location of the tumour

(4) In a large pleural effusion, the oesophagus is displaced away from it

(5) In dilatation of the right side of the heart the oesophagus is displaced in its lower third to the right and backwards

(6) In scoliosis, the displacement is more apparent than real and depends on the type of scoliosis.

PLATE 226
Normal Oesophagus Outlined by opaque substance as seen in the half left view (1) Oesophagus (2) Aortic arch (3) Heart shadows (right auricle and ventricle)

Spasm of the oesophagus. In oesophageal spasm, the fluid is delayed in the oesophagus for a variable time

Causes —

(1) Injury of the oesophageal wall from swallowed foreign bodies or corrosive fluid produces spasm which may occur in any part of the oesophagus, but occurs most often in the upper third The spasm, which may persist for three or four days, is often only momentary and continues so long as the patient complains of pain

(2) Spasm at the lower end of the oesophagus occurs

(*a*) In idiopathic achalasia when the oesophagus shows marked dilatation

(*b*) When associated with disease of the stomach, often a high lesser curve ulcer is present

(*c*) When associated with carcinoma of the oesophagus or cardiac end of the stomach, the spasm is of sudden onset In men over the age of 35 this must always be suspected of concealing a carcinoma unless an ulcer of the stomach can be demonstrated

Types of dilatation of the oesophagus

(1) Idiopathic, from cardiospasm (Plates 227, 228, 229), shows the following changes —

(*a*) The oesophagus is seen to be dilated and in some cases may be filled up with barium before any is seen to pass into the stomach

(*b*) The absence of antiperistaltic waves
(*c*) The end of the funnel formed by lower part of the oesophagus is pointed and regular as it enters the cardiac orifice

(2) When associated with carcinoma of the oesophagus it shows —
(*a*) The oesophagus only slightly dilated
(*b*) Antiperistaltic waves may be seen
(*c*) An irregular defect of the wall of the oesophagus If at the cardiac orifice, the normal funnel-shaped outline is irregular

Oesophageal pouch (Plate 230) *This shows a half moon shadow of* the opaque fluid on one side of the oesophageal wall usually in the upper third The opaque fluid is seen to flow into the pouch first, before emptying into the lower part of the oesophagus From an operative point of view it is necessary to decide the exact relation of the pouch to the oesophagus Films should be taken in the postero-anterior and lateral positions, to show whether the pouch is to the right or left of the oesophagus

Carcinoma of the oesophagus (Plates 231 and 232) This shows an irregularity of the oesophageal wall with some degree of stenosis at the level of the lesion and dilatation above The chest should be X-rayed in the postero anterior position as well in order to eliminate an aneurysm or neoplasm invading the oesophagus from without The earliest evidence of carcinoma of the oesophagus may be —

(1) Excessive barium shadow in the valecula on swallowing

(2) Cardiospasm not associated with dilatation of oesophagus or disease of the stomach

PLATE 227
Achalasia of Oesophagus Note the dilatation of oesophagus and the smooth lower end (1) at the cardiac orifice of the stomach (2) Stomach gas bubble

PLATE 228
Cardiospasm with Gross Dilatation of Oesophagus The oesophagus and the stomach are filled with opaque substance.
(1) Oesophagus. (2) Stomach

PLATE 229
Large Dilatation of Oesophagus (congenital) containing food filling the right central lung field

PLATE 230
Oesophageal Pouch and Oesophagus filled with Contrast Media (1) Pouch. (2) Oesophagus. The pouch presses on the oesophagus. On the screen when the pouch is full the contrast media can be seen to spill over into lower oesophagus

Table showing the differential diagnostic points between Achalasia Carcinoma and Pouch of the Oesophagus

Differences between	*Achalasia*	*Carcinoma*	*Pouch*
Oesophagus dilated	Marked	Slight	—
Position	At cardiac orifice	Any part	Upper part usual
Contour	Regular	Irregular	Pouched

GASTRO-INTESTINAL TRACT

The outline of the gut cannot be seen on fluoroscopy unless filled with opaque media or gas

For the investigation of the gastro-intestinal tract a mixture is used composed of the following For barium meals 4 oz barium sulphate held in suspension with mucilage of acacia or malted milk in 10 oz water For barium enemas 8 oz barium sulphate in mucilage of acacia to 30 oz water is used or 30 oz of a 12 per cent solution of thorium oxide It is often more satisfactory to use a proprietary preparation such

PLATE 231
Neoplasm of Middle Third of the Oesophagus.

PLATE 232
Carcinoma of Oesophagus filled with Barium Note the irregular areas.

PLATE 233

Barium Meal in Normal Stomach

(1) Gas bubble—"Magenblase."
(2) Lesser curvature
(3) Greater curvature
(4) Body of stomach
(5) Antrum
(6) Pylorus on right of the 4th lumbar vertebra.
(7) Duodenal cap
(8) Second part of duodenum
(9) Level of iliac crests

as Horlick's X-ray Shadow Food, which is in powder form ready mixed and only requires diluting with water to the desired consistency for the investigation.

It must be remembered that the gastro-intestinal tract varies in position in the erect and recumbent postures.

THE STOMACH

In the erect position, the stomach containing the opaque medium hangs from its ligaments like a tube suspended at its two ends—the cardiac and pyloric. In the recumbent position it lies at a higher level and is brought forward where it crosses the spine. This may cause an apparent filling defect if its presence is forgotten.

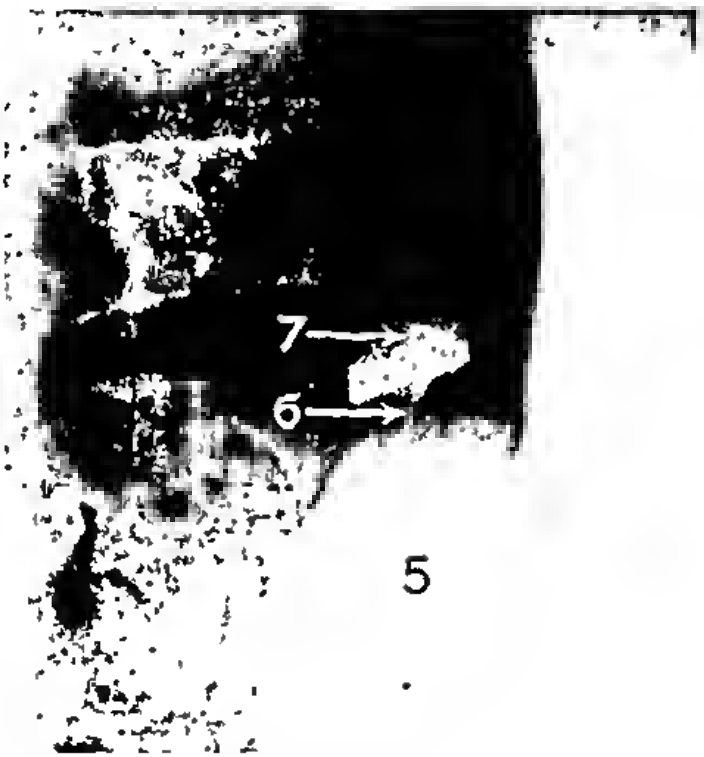


PLATE 234.
Oblique view of 233.

RADIOLOGICAL DIVISIONS OF THE STOMACH
(Plates 233 and 234)

This shows the following divisions :—

(1). Cardiac end with air-bubble ("Magenblase").
(2) Body.
(3) Antrum.
(4) Pylorus.

The stomach outline shows :—

(1) Greater curvature
(2) Lesser curvature
} seen in the postero-anterior view.

(3) Posterior wall
(4) Anterior view
} seen in the oblique view.

EXAMINATION

In examination of the stomach the following points must be noted :—

(1) Position of the stomach in the erect posture
(2) Any abnormality in the contour of the stomach wall
(3) Tone of the stomach wall
(4) Type or absence of peristaltic movement
(5) The emptying-rate
(6) The shape of the duodenal cap
(7) The position of any tenderness

Though the above factors are intimately connected, they must be examined separately to assess their true relation in the clinical picture It is evident that full information on these factors can be obtained from screen examination *alone*, and that the only value of a radiograph is to obtain a record of what the radiologist has seen at radioscopy, but it is meaningless without his report unless very gross disease exists

Contours of the stomach wall (Plate 233) The greater curvature always shows some irregularity of outline, varying from case to case and from time to time It is often due to gas pressure from the colon A defect produced by a neoplasm of the greater curvature can only be recognised by demonstrating on successive films a persistence of the same irregularity The other outlines of the stomach are, in the normal, quite smooth and of regular outline, the lesser curvature at the cardiac end may, however, sometimes show the striation of one to three muscle bands which can be traced running obliquely across towards the greater curvature

The position of the stomach in the erect posture. In the average individual, the stomach hangs in the erect position so that a line joining the iliac crests passes through the lowest part of the lesser curvature In thin patients, the stomach often hangs somewhat below this level, and, in more robust patients, above it

Low-placed stomach The lowest part of the lesser curvature lies well below the line joining the iliac crests It may give rise to no symptoms but is of significance in thin patients when associated with tenderness in the region of the ziphisternum The lowered general abdominal tone and the failure of other abdominal contents to help to hold the stomach in the normal position allows the whole weight of the gastric contents to pull on the ligaments of the stomach, producing pain and tenderness in the abdomen just below the ziphisternum

A further stage is seen when the stomach hangs at the level of the hip-joint and is without any peristaltic movements

High-placed stomach The lowest part of the greater curvature lies well above the line joining the iliac crests It is seen in —

(*a*) Fat patients
(*b*) General hypertonus
(*c*) When the other abdominal contents push the stomach upwards, e g by (i) the large gut full of gas, (ii) an ovarian cyst
(*d*) Stomach pulled up by a neoplasm invading the lesser omentum

Displacement of the stomach. The stomach can be displaced to the right or left by extrinsic causes

(1) To the *right* by —
  (a) Adhesion between the duodenal cap and the gall bladder
  (b) Gas distension of the splenic flexure of the colon
  (c) An enlarged spleen
  (d) An enlarged left kidney
(2) To the *left* by —
  (a) Enlargement of the liver
  (b) A pancreatic cyst
  (c) A retroperitoneal tumour
(3) The antral and duodenal area are pulled upwards and to the right by pericholecystic adhesions
(4) In chronic appendicitis when adhesions have formed, the duodenum and antrum may be pulled downward and to the right so that they come to lie above the right sacro-iliac joint

Peristaltic movements of the stomach. The peristaltic wave is seen in the normal to begin simultaneously in both the greater and lesser curvatures, half-way up the lesser curvature, and travels towards the pylorus It is usual to see the two waves passing along the stomach wall at the same time More than two waves passing simultaneously is evidence of *hyperperistaltic* action A peristaltic wave usually stops short of an area involved by neoplasm and may be seen to reform on the distal side of the neoplasm and pass on to the pylorus.

The "Magenblase" (Plate 233) The air bubble at the cardiac end of the stomach is known by the German term 'Magenblase" and is best seen with the patient in the erect position It is usually semicircular in outline but may be comet-shaped The semicircular outline is produced by the rounded outline of the cardiac end of the stomach The opaque fluid in the stomach limits the outline of the lower end of the Magenblase If the stomach is of the long or ptosed type, the approximation of the greater and lesser curvature of the stomach makes the air bubble appear comet-shaped

The size of the Magenblase varies much from time to time and in different stomachs, depending on the amount of gas swallowed Very little of the gas is produced in the stomach itself

The Magenblase is of little significance except in *air swallowers*, when the patient can be seen to eructate and at once swallow more air The air bubble then becomes larger than previously till it may fill two thirds of the stomach

If the semicircular part of the Magenblase at the cardiac end of the stomach appears irregular it is evidence of deformity of the cardiac end of the stomach which may be due to carcinoma The patient should then be examined in the Trendelenburg position so that the barium meal fills the cardia, when a carcinoma producing the deformity will be detected

Abdominal tenderness. Geoffrey Fildes (London) has pointed out that gastric tenderness is of great importance to distinguish between active ulcer, healed ulcer, and neoplasms of the stomach The tenderness meant here is that which can be localised to one spot on palpation An active ulcerative condition of the stomach whether acute or chronic which has not received treatment, is acutely tender to deep palpation, while a non-active indolent ulcer is only slightly tender Malignant

conditions of the stomach are not locally tender, though a diffused general tenderness sometimes exists, but is little in comparison with the gross deformity of the stomach

Abdominal tenderness is perhaps the most important sign in arriving at a differential diagnosis between malignant and simple ulceration of the stomach This sign can only be elicited by the careful palpation of the patient's abdomen when screened in the upright position In the hands of an expert radiologist who knows the value of the sign, it is of primary diagnostic importance and explains the reason why the radiograph of the stomach can only be read when the radiologist's report on the abdominal tenderness is known

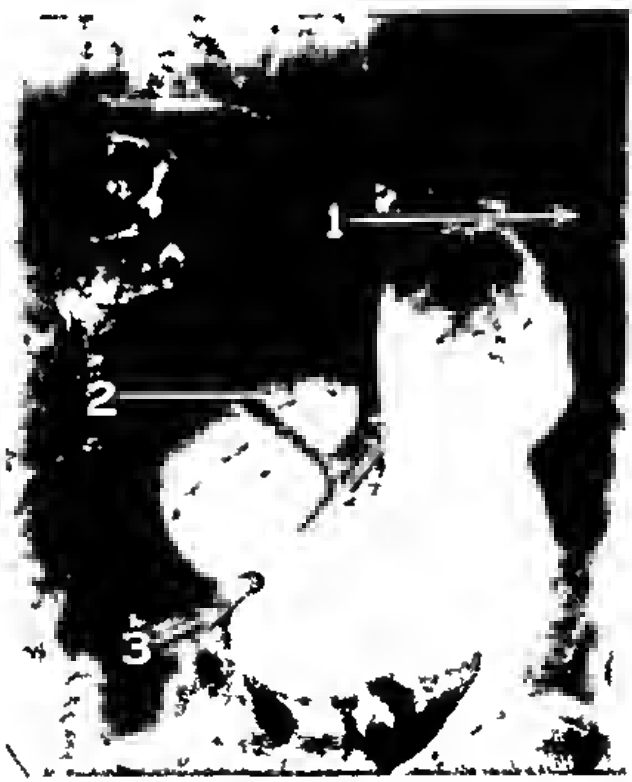


PLATE 235

Marked Ptosis of Stomach (1) Level of iliac crests (2) Pylorus to left of spine (3) Peristaltic waves indicated by arrows The stomach is of fair tone The barium has become mixed with food residue in the stomach which accounts for the apparent poor homogeneity of the meal It must not be mistaken for neoplasm in the stomach.

The emptying-rate. The normal stomach should be half empty in one hour, and completely empty in six hours with the meal described With increased motility of the stomach, the meal empties more rapidly than in the normal The stomach which shows decreased motility and ptosis may, however, have a normal emptying rate The emptying rate is delayed in —

(*a*) Pyloric obstruction
(*b*) Pylorospasm
(*c*) Ptosis (frequently)

The emptying rate is more rapid in :—

(*a*) Duodenal irritation.
(*b*) Prepyloric ulcers.
(*c*) Achlorhydria.
(*d*) Neoplasms of the stomach not producing obstruction of the pylorus or antrum.

DISEASES OF THE STOMACH

GASTROPTOSIS

(Plate 235)

In gastroptosis the stomach shows the following changes :—

(1) The position of the stomach when filled with a barium meal is low. It is

PLATE 236.
Pyloric Obstruction. The barium lies in a pool in the stomach due to its loss of tone. The duodenal cap cannot be seen.

PLATE 237.
Leather Bottle Stomach. The rugae instead of running in the body of the stomach in the longitudinal axis are irregular and honeycombed. The outline of the whole stomach is irregular and shows numerous defects.

below the level of the iliac crests and may be as low as the level of the hip-joint.

(2) The gastric tone is subnormal, hypotonic or atonic.

(3) The peristaltic action is normal or absent.

(4) Abdominal tenderness is frequently situated just below the xiphisternum. Palpation of the stomach itself produces no evidence of tenderness in simple gastroptosis.

(5) The duodenal cap is of normal outline and contour but may often be dilated with the rest of the stomach. The cap itself is usually displaced downwards from its normal position on the right of the third lumbar vertebra and may even be found at the level of the fourth on the *left* side.

(6) The emptying rate is usually delayed sometimes very markedly to twelve hours but may be normal

Gastroptosis of the stomach is usually associated with a general ptosis of the other abdominal contents A right renal ptosis often co exists sometimes associated with hydronephrosis

THE EFFECT OF PYLORIC OBSTRUCTION ON THE STOMACH
(Plate 236)

The commonest causes of pyloric obstruction are —

(1) Pyloric stenosis from duodenal ulceration producing scar tissue and occlusion of the pylorus

PLATE 238
Carcinoma of the Body of the Stomach with Complete Obstruction

PLATE 239
Carcinoma of the Antrum and Distal Part of the Body of the Stomach.
(1) Duodenal cap (2) Duodeo-jejunal flexure

(2) Duodenal spasm from active duodenal or prepyloric ulceration
(3) Neoplasm in the prepyloric or pyloric region

In pyloric obstruction the stomach shows the following changes —
(1) The position of the stomach when filled with a barium meal is very low
(2) The gastric tone is hypotonic or atonic
(3) The peristaltic action is subnormal or absent
(4) Gastric tenderness varies with the causative factor

Gastric tenderness is absent in pyloric stenosis produced by duodenal ulceration which is not active or healed but which has scarred the duodenum It is very acute on palpating the duodenal cap when active duodenal ulceration is present In

PLATE 240
Crater of Lesser Curve Ulcer indicated by arrow

neoplasms of the prepyloric or pyloric region it is usually absent or may be replaced by a general abdominal tenderness

(5) The duodenal cap is often not definable or much deformed and tender when active ulceration and spasm of the pylorus is the causal factor

FILLING DEFECTS OF THE STOMACH

Filling defects can be seen on the screen as alterations in the normal contour of the stomach They must be distinguished from gastric spasm by screening again in about one hour or by serial X ray films when spasm or defects can be differentiated, the defect alone being constant in detail

PLATE 241
Prepyloric Ulcer of the Lesser Curvature marked by arrow

The commonest causes of filling defects of the stomach are —

(*a*) **Intrinsic**
- (1) Carcinoma
- (2) Polyp
- (3) Syphilitic invasion of the stomach wall

The last two conditions are very rare

(*b*) **Extrinsic** Extragastric tumours invading the stomach wall

(*c*) **Artefacts** may produce apparent filling defects in the stomach The commonest causes are —
- (1) The stomach half filled with non opaque food indicating improper preparation
- (2) If the patient is lying on his back during the radiographic examination the spine causes a pressure defect in the antral region

CANCER OF THE STOMACH

(Plates 237 to 239)

Cancer can occur in any part of the stomach it occurs least frequently at the cardiac end

Evidence of gastric carcinoma may be divided into *direct* and *indirect*

Direct evidence is —

(1) The demonstration of a filling defect

(2) The palpation of the neoplasm in the stomach wall

Indirect evidence is spasm of the lower end of the oesophagus with no demonstrable lesion of the oesophagus in a patient, usually over the age of thirty-five who has rapidly developed symptoms of achalazia Often it is possible by examining the patient in the Trendelenburg position, to demonstrate a filling defect of the cardiac end of the stomach, or the ' Magenblase ' in the upright position may show a defect

A neoplasm of the stomach is seen as a defect in the outline of the contrast media as opposed to an ulcer It may be localised to the lesser or greater curvature, anterior or posterior wall

Annular carcinoma of the stomach is frequently seen in the body and antrum, the proximal part of the stomach being normal and the annular ring of growth producing a defect

In scirrhus carcinoma of the stomach the whole stomach wall shows irregular outline with persistent defects and the absence of peristaltic waves (Plate 237)

A carcinoma involving the cardiac end of the stomach shows —

(1) Irregularity of the cardiac end of the stomach which can best be demonstrated by examining the patient lying in the Trendelenburg position so that the cardiac end of the stomach is filled with the opaque media Sometimes in the upright position it is possible to see a defect in the normal rounded contour of the ' Magenblase '

(2) The stomach is usually high placed and drawn up from infiltration of the upper part of the lesser curvature and lesser omentum

(3) Normal peristaltic movements are seen distal to the lesion

(4) The mobility of the stomach is usually somewhat increased

(5) The duodenal cap is normal

(6) There is a complete absence of abdominal tenderness

(7) Cardiac spasm occurs frequently, achalazia being often the first symptom

A carcinoma of the body of the stomach shows (Plates 238) —

(1) A localised, annular or extensive defect of the body of the stomach which is often palpable on screen examination

(2) The position of the stomach is usually normal or higher than normal if infiltration of the omentum has occurred

(3) The gastric tone is normal or increased.

(4) Peristaltic movement is normal, except in the region of the defect where it is absent

(5) The gastric mobility is increased

(6) The duodenal outline is normal

(7) There is no localised area of tenderness, but in the advanced cases a generalised gastric tenderness occurs

A carcinoma of the antrum of the stomach shows —

(*a*) *In the early stages*

(1) An antral defect, which is often difficult to detect, is seen most often on the greater or lesser curvature

(2) The position of the stomach is very variable and is not affected at first by the growth

(3) The gastric tone is as a rule decreased

(4) The peristaltic movement is not affected in the proximal part of the stomach but is absent in the region of the neoplasm

(5) The duodenal cap in the early stage is normal or even dilated

(6) Gastric tenderness is absent

PLATE 242

Stomach with Gastroenterostomy The stoma is indicated by an arrow There is no duodenal cap and the barium passes via the stoma.

(b) In the later stage

(1) The antral defect causes obstruction

(2) The position of the stomach is high if infiltration of the lesser omentum has occurred, but may be normal or low if the lesser omentum is not affected

(3) The gastric tone is decreased or absent

(4) The peristaltic movement is absent

(5) The duodenal cap is not demonstrable and there is much delay in emptying Complete retention of the barium meal may occur with the appearance of pyloric obstruction

(6) Gastric tenderness is absent or slight

GASTRIC ULCER

(Plate 240)

The gastric ulcer is probably the commonest demonstrable lesion of the stomach, it occurs most often on the lesser curvature or posterior wall, rarely on the anterior wall

Evidence of a gastric ulcer may be divided into direct and indirect

The direct evidence, which must be present for an absolute diagnosis, is —

(1) The demonstration of an ulcer crater

(2) Tenderness localised to the crater

The indirect evidence is —

(1) Spasm of the greater curvature

(2) Spasm of the oblique muscles of the stomach

(3) Spasm of the antrum

(4) Spasm of the duodenal cap

In some cases all the above changes are present

An active ulcer is acutely tender on palpation, a healing ulcer shows little tenderness, and a healed ulcer is not tender

A gastric ulcer which has undergone neoplastic changes is not tender and it is difficult to demonstrate as neoplastic unless it is about one inch across and without tenderness, when a neoplastic change may be suspected, or unless it can be demonstrated that within an interval of some days the ulcer crater is becoming progressively larger and yet tenderness is absent On the whole, gastric ulcers rarely undergo neoplastic changes

In a gastric ulcer the position of the stomach is usually normal or may be low

Gastric peristalsis and mobility are usually diminished

In a prepyloric ulcer, the speed of emptying is increased and the duodenal cap usually remains always filled as the pylorus remains patent. The position of the maximum tenderness is proximal to the pylorus where sometimes the ulcer can be demonstrated (Plate 241)

DIVERTICULA OF THE STOMACH

These are usually found accidentally during examination as a finger-like process with smooth walls and a smooth stoma outline They are not tender and are very rare, but occur most often high on the lesser curvature

HERNIA OF THE STOMACH THROUGH THE DIAPHRAGM

(See Diaphragmatic Hernia, page 165)

ADENOMA OF THE STOMACH

These are difficult to demonstrate until they have reached a large size, when they can be seen bulging with a smooth outline into the opaque media. The stomach wall on either side of the adenoma shows no evidence of any infiltration, which distinguishes it from a malignant growth

THE POST-GASTROENTEROSTOMY STOMACH

(Plate 242)

The stomach with a gastroenterostomy shows if the stoma is satisfactory, no opaque residue at the end of half an hour The stoma should not he tender and

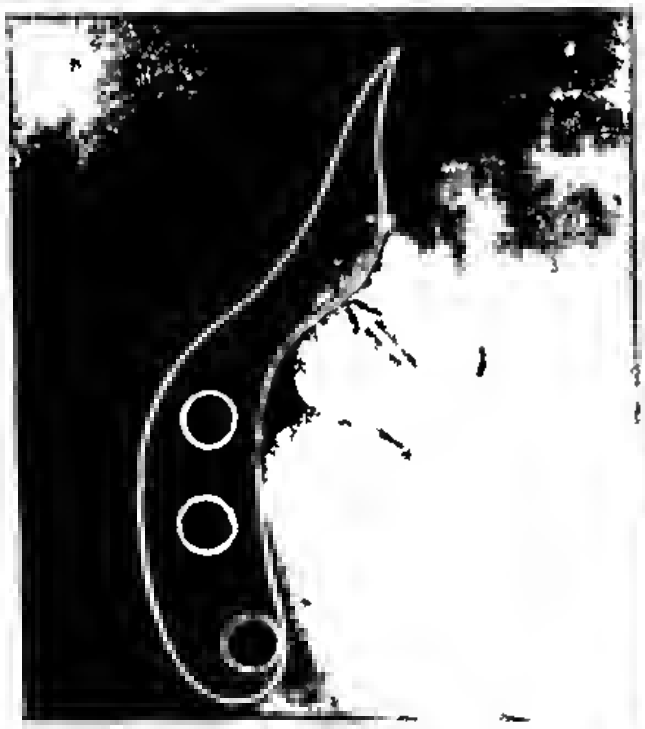


PLATE 243
Half moon Shaped Deformity of Duodenal Cap from Pressure of Gall bladder indicated by arrow The lower part of the gall bladder contains three opaque stones.

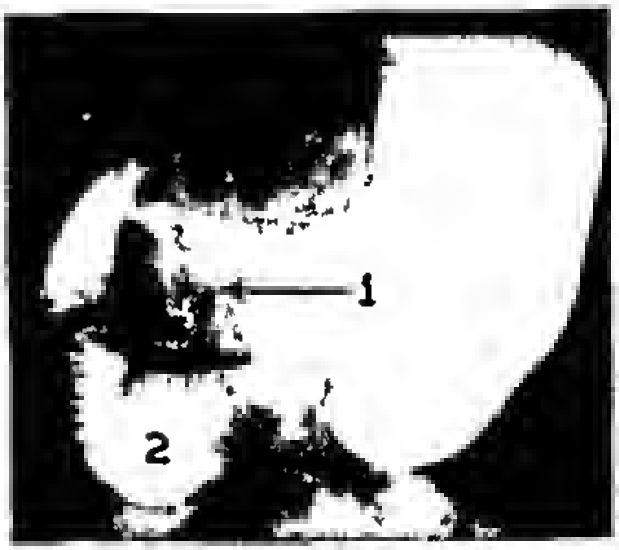


PLATE 244
Neoplasm of the Head of the Pancreas. (1) Area of invasion of antrum (2) Duodenal ileus from partial obstruction from pressure of the enlarged head of the pancreas.

should begin to function as soon as the meal enters the stomach The meal should be seen to enter at once into the small gut

Tenderness of the stomach suggests a jejunal ulcer, though an ulcer as such is rarely demonstrable as it may be mistaken for a puckering in the stoma wall produced at the operation.

When the stoma is not tender and acting well, tenderness may he present in the antral region suggesting an antral or duodenal ulcer, though these areas may be occluded hy spasm to the passage of the opaque meal.

Tenderness below the left ribs but with a normal stoma function suggests that the stomach is dragging on a loop of the gastroenterostomy, which is of insufficient length

THE DUODENUM

The duodenum consists of three parts —

(1) The superior part, which forms in its proximal half the duodenal cap In the orthotonic stomach its direction is upwards backwards and to the right its position in relation to the stomach depends on the position of the latter as the position of the cap is relatively fixed by its short ligament In some cases the cap lies posterior to the antrum

(2) The descending part Its direction is downwards to the right of the head of the pancreas

(3) The inferior part is directed forwards upwards and to the left to the duodeno jejunal flexure which is situated in the erect posture one third of the way up the lesser curvature of the stomach and posterior to it Care must always be taken not to confuse the outline of the duodeno-jejunal junction with an ulcer of the lesser curvature of the stomach in the postero-anterior view The true position can be seen by turning the patient half left when the duodeno-jejunal junction will be seen to lie behind the stomach

RADIOGRAPHIC APPEARANCE

(Plate 233)

The pyloric canal is seen as a constriction between the antrum and the duodenal cap The opaque meal passes through it on the screen when systole of the stomach occurs The peristaltic wave does not force the meal into the duodenal cap but this is done by a contraction of the stomach as a whole with simultaneous opening of the pylorus A peristaltic wave may be seen sometimes to be continued into the cap itself

The sphincter of the pylorus may be forced by the radiologist by manipulating the opaque meal against the pylorus while squeezing the antrum The duodenal cap fills and empties by a sudden contraction of it as a whole though all the opaque fluid may not be forced out of it

The normal duodenal cap (Plate 235) is cone-shaped with its apex upwards and shows many variations Abnormalities of outline can only be recognised on the screen when the position of any tenderness and irregularity in its contour can be recognised The meal expelled from the duodenal cap on its contraction traverses the rest of the duodenum rapidly without any segmentation taking place

Abnormal variations of the pylorus

(1) In infants with congenital pyloric stenosis none or little barium passes into the small gut when examined several hours after the opaque meal which if not vomited remains in the stomach

(2) Pylorospasm is present when on examination after the opaque meal it is impossible to force any barium through the pylorus till relaxation takes place when the pylorus behaves normally

Normal variation of the duodenal cap The duodenal cap may lie behind the antrum to the right on the same level as the antrum or below it The relation of the duodenal cap to the stomach is governed by the position of the stomach since the duodenum is relatively fixed

Abnormalities of the duodenal cap

Duodenal spasm may show either of the following changes —

(*a*) The filling of the cap is transient The meal will at first not fill the cap and any filling which occurs is only momentary Evidence of this can be seen on screen examination alone

PLATE 245
Tuberculous Adhesions of Small Gut Note the numerous fluid levels

(*b*) A localised spasm The duodenal cap fills well, except in one part, in which spasm is present This again can only be recognised on screen examination

Duodenal spasm indicates duodenal irritation, the chief causes being —

(*a*) organic intrinsic, from a duodenal ulcer,

(*b*) organic extrinsic

(i) From a gastric ulcer—usually situated on the lesser curve

(ii) from cholecystitis and gallstones

(iii) from appendicular irritation,

(iv) from spasm of colon associated with colitis

Spasm of the duodenal cap *per se*, and without definite clinical signs, is unreliable evidence of gastro-intestinal disorder It may occur from distaste for the opaque meal and at a subsequent examination the duodenal cap will often be found to be normal

Organic defects of the duodenal cap.

(1) An *acute duodenal ulcer* This can only be diagnosed on the demonstration of a definite crater and tenderness localised to the cap it is associated with spasm, usually transient, which may be local or general in the cap region.

(2) In a *healed duodenal ulcer*, giving rise to scar formation but not pyloric obstruction, the appearance is similar to the above section, but there is absence of tenderness and the cap usually fills easily on manipulation, but is deformed

(3) In a *duodenal ulcer with pyloric obstruction*, the outline of the cap cannot be seen on attempting to manipulate the meal into it and the stomach shows loss of tone and general atony, which is secondary to the pyloric obstruction In the absence of tenderness, the condition is due to cicatrisation of the duodenum producing absolute pyloric obstruction When tenderness is present, it is evidence of an active duodenal ulcer with swelling of the mucous membrane which may cause the pyloric obstruction The latter is therefore only absolute so long as the swelling persists

Extrinsic causes of deformity of the duodenal cap.

(1) The commonest cause is gallstones and cholecystitis, with adhesions between the gall-bladder and duodenum Typically this produces a 'half-moon" deformity (Plate 243) of the upper and outer quadrant of the cap from pressure of a gallstone-filled gall bladder The gallstones may be non-opaque. The position of the stomach in such cases is high and the antrum is displaced to the right Tenderness in the cap region can rarely be distinguished from gall-bladder tenderness under these conditions (see Gall bladder examination, page 234)

(2) Cyst or carcinoma of the head of the pancreas In this condition the base of the duodenal cap and the greater curvature of the antrum are defective, the cyst may be palpable, the second and third parts of the duodenum are often dilated and show ileus from pressure on the duodeno-jejunal junction (Plate 244)

The patent pylorus. In this condition both the pylorus and duodenal cap appear to remain filled till the stomach is empty

The chief causes are —

(1) Hypermotility of the stomach associated with a high-placed stomach

(2) Prepyloric ulcer The ulcer cannot frequently be demonstrated The antrum is tender and the motility of the stomach is usually increased The stomach position may be normal or slightly ptosed

(3) Infiltration of the pylorus from carcinoma of the antrum Tenderness of the antrum is absent, peristaltic waves fail to reach the antrum, which often shows a defect The emptying rate of the stomach is increased

PYLORIC STENOSIS

Pyloric stenosis may be relative or absolute the chief causes being —

(1) Relative
   (*a*) Pyloric spasm persisting for several hours, leading to failure of the stomach to empty usually caused by irritation from an ulcer

(2) Absolute
   (*a*) A duodenal ulcer proximal to the pylorus and affecting the sphincter, with obstruction from spasm and swelling of mucous coats Duodenal tenderness is present

PLATE 246
Normal Appendix Hanging over Brim of Pelvis. Outline of caecum is indicated by a black line

PLATE 247
Cancer of Caecum Note that only the appendix can be seen

   (*b*) A scarred pylorus produces obstruction from cicatrisation It is not tender unless an active ulcer is present
   (*c*) A neoplasm of the antrum causing blocking of the pylorus It is not tender The mass at the antrum is often palpable

DUODENAL ILEUS

(Plate 244)

This shows dilatation of the second and third parts of the duodenum rarely extending to the first part On the screen in the erect position the meal is seen to leave the cap but instead of passing in a single flow to the duodeno jejunal flexure it rests in the most dependent part of the duodenum The duodenal bore is seen to be dilated antiperistaltic waves may occur and the food may be forced backwards

PLATE 248

Normal Barium Enema

(1) Rectum
(2) Sigmoid flexure
(3) Descending colon
(4) Transverse colon
(5) Ascending colon
(6) Caecum
( ) Small gut

into the stomach The loop may empty after some delay, or when the patient lies down

The principal causes of duodenal ileus are —

(1) *Congenital* This is most often due to abnormal high fixation of the duodeno-jejunal flexure producing kinking when the patient is standing in the erect position

(2) *Acquired* It is most often produced by enlarged glands at the root of the mesentery pressing on the third part of the duodenum The pressure may be caused by —

(*a*) Tuberculous glands
(*b*) Neoplastic infiltration of the glands
(*c*) Cyst or neoplasm of the head of the pancreas

THE SMALL GUT

Radiographically, it is impossible to show definitely when the jejunum ends and the ileum begins The jejunum has a feathery outline which is produced by the valvulae conniventes This appearance of the small gut in its upper part gives rise to the so-called snowfall effect ' when filled with barium In the ileum, the feathery appearance is lost and the bowel becomes visible as loops

Hypermotility of the stomach is usually associated with hypermotility of the small gut but the colon may show no increase of motility

In order to fill the small gut for radiographic examination, the patient should be given 10 fluid oz of opaque meal to drink and be directed to sip it slowly and continuously so that half an hour will be occupied in the process The examination is begun at the end of this period

The following conditions can be recognised in the small gut —

(1) **Stenosis of the small gut** The loop proximal to the obstruction shows dilatation, which must be verified for its persistence

(2) **Adhesions of the small gut** (Plate 245) The gut shows a general "tube" outline with numerous fluid levels, the so-called "mirrors" The "feathery ' appearance is lost

(3) **Spasm of the ileo-caecal valve.** This is shown by dilatation of the small gut with failure of the meal to enter the caecum at six hours The chief causes are —

(*a*) Functional spasm of the ileo-caecal valve
(*b*) Organic spasm of the ileo-caecal valve
(*c*) Appendicitis
(*d*) Tuberculosis of the caecum
(*e*) Neoplasm of the caecum

The diagnosis of the causal factor is made by giving a barium enema so that the caecum can be examined to eliminate appendicitis tuberculosis and neoplasm of the caecum Tuberculous glands in the mesentery can cause organic spasm of the ileo caecal valve The diagnosis of **functional** spasm must only be made when all other causal factors have been eliminated

THE LARGE GUT
(Plate 248)

The normal colon is 130-160 cm in length and 6-8 cm in width It should be examined for —

(1) Position (2) Emptying rate (3) Haustration (4) General width (5) Tone

The emptying-rate of the colon is investigated by giving a barium meal *per os* and making daily examination till no meal remains in the colon The normal colon should empty in three days, though the limits of the physiological normal are very wide Unless almost complete obstruction is present, it is difficult to show neoplasms of the colon by this method The giving of a barium enema is preferable because the colon is then distended by the positive pressure of the enema

The caecum can be examined either by a barium enema or by a barium meal given eight hours before examination The appendix may, or may not be filled

The preparation of the colon for a barium enema is best made by giving a soap and water enema six hours before examination The soap and water enema should be followed by a saline washout which should be repeated till it is returned uncoloured The saline washout should be repeated again one hour before the examination To prevent residue from the small gut reaching the colon, for twenty-four hours before the examination the patient should be given a low residue diet Failure to prepare the patient adequately may invalidate the examination, as faecal shadows may be mistaken for defects in the wall of the colon

THE APPENDIX

The filled appendix must be examined for —

(1) Its position in relation to the caecum This is easily seen on screen examination when filled

(2) The length of the appendix, and whether its tip is fixed to any other organ, must be seen

(3) Tenderness of the appendix on palpation, when visualised on the screen The normal appendix is not tender

(4) Motility The appendix should empty with the caecum failure to do this is an indication of impaired motility and stasis, which is abnormal, though not in every case pathological

APPENDICITIS

(Plate 246)

(1) The demonstration of the fixation of the tip of the appendix to an adjoining organ is positive evidence of appendicitis, either acute or chronic.

(2) Stasis in the appendix with tenderness is positive evidence of an inflamed appendix, especially if accompanied by stasis in the terminal ileum

(3) A retrocaecal appendix with stasis, even in the absence of tenderness, should be regarded as abnormal

THE CAECUM

The normal caecal outline is regular It should be examined full and partly empty

Diseases of the caecum.

(1) *Spasm of the caecum* occurs as part of the general spasm of spastic colitis (see Spastic Colitis, page 224)

(2) *Defects of the caecum* (Plate 247) The chief causes are —

(*a*) Neoplasm

(*b*) Tuberculosis.

Differential diagnosis between neoplasm and tuberculosis of the caecum is shown in the following table —

	Neoplasm	*Tuberculosis*
Small gut	No adhesions	Usually adhesions
Chest	Nil	Active tuberculosis
Age	Over 45	Under 45

POSITION OF THE NORMAL COLON

(Plate 248)

The position of the colon varies about three inches when standing up and lying down Marked variations between the two positions is evidence of lax ligaments and enteroptosis

HAUSTRATION

Haustrations are the numerous blunt digitations found in the transverse and descending colon and to a less extent in the ascending Though they are independent of peristaltic waves, they vary considerably from time to time and appear to be influenced by the general colonic tone They are increased in spastic hypertonic constipation and so-called " spastic colon,' but are absent in ulcerative colitis when the colon has a ribbon like appearance

DISEASES OF THE COLON

Dilatations of the Colon

(1) *Hirschsprung s disease in children* (Plate 249) In this condition the sigmoid and ascending colon are enormously dilated and there is failure of the mechanism of evacuation so that the colon becomes loaded with faeces *The degree of dilatation is shown by a barium enema*

(2) *Megacolon* In this the length of the colon is increased, with sometimes an extra redundant loop between the sigmoid colon and the splenic flexure There is usually no dilatation, but there is absence of haustrations

(3) *I ocalised dilatation* This usually occurs just below a neoplastic lesion and is especially marked in the rectal colon

Carcinoma of the Colon (Plates 250, 251, 252) should be demonstrated by means of a barium enema The carcinoma may produce either defects or strictures of the wall of the colon In the early stages the normal smooth rounded outline of a single haustration may appear flattened in contrast *with the rest of the gut At a later* stage the haustrations may be absent over a small length of the colon for about an inch and the lumen of the bowel may be diminished Where ulceration has taken place an irregular defect which is filled with barium develops beyond the lumen of the bowel The lumen of the bowel may be diminished and *the growth be seen bulging* into it In some cases the lumen *may be reduced* to an eighth of an inch across through which the barium enema flows The colon above the neoplasm often appears normal, but below dilated

PLATE 249
Hirschsprung's Disease The enormously dilated colon is shown filled with gas (1) The stomach (2) is displaced downwards and contains a barium meal some of which has passed into the small gut

PLATE 250
Carcinoma of Ascending Colon
(1) Butt of caecum (2) Neoplastic area
(3) Hepatic flexure.

PLATE 251
Carcinoma of Proximal Half of Ascending Colon
Demonstrated by barium enema

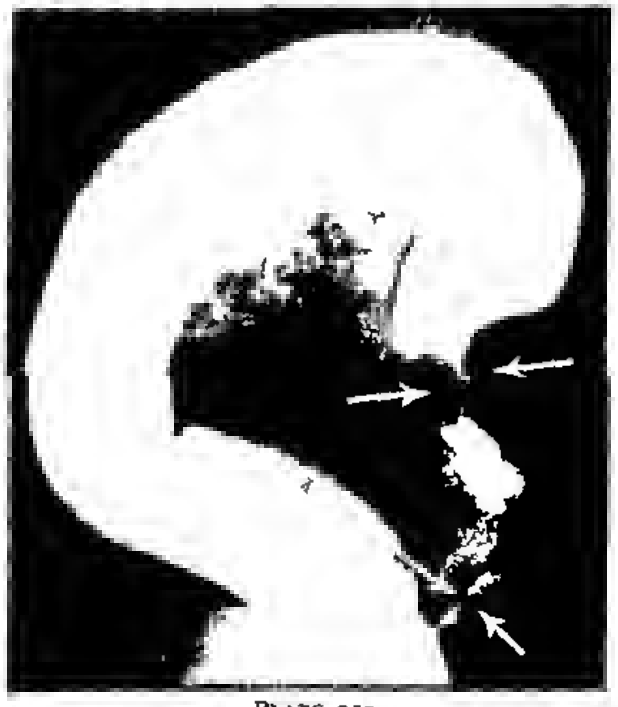


PLATE 252
Carcinoma of Distal End of Descending Colon
Note the dilatation of rectal and sigmoid colon with the carcinomatous area irregularly canalised

Where stricture from a ring carcinoma is present the colon below the stricture is dilated and the gut constricted at the site of the stricture is easily recognisable Where the carcinoma causes complete obstruction the barium enema will show dilatation of the gut below the stricture and the opaque fluid at the site of the obstruction may appear to end in a blunt or funnel shaped end (see Plate 252)

COLITIS

(1) In ulcerative colitis (Plate 253) the gut shows complete loss of haustration and there is marked tenderness on palpation The gut fills rapidly with the barium enema and has a ribbon like outline which is specific for the condition

(2) Spastic colitis is recognised by seeing the colon in spasm over a large segment

PLATE 253
Ulcerative Colitis The barium enema has been partly evacuated

which is tender the descending colon is most often affected The haustration of the whole colon is increased but most markedly in the spastic segment

DIVERTICULA

(Plate 254)

Diverticula of the colon are demonstrated with a barium enema by showing the presence of smooth stalked defects of round outline varying in size between a pea and a cherry attached by a stalk to the well of the colon These defects are filled with barium and are seen lying beyond the normal outline of the colon Though usually multiple they may be single and occur most frequently in the lower colon

In diverticulitis the smooth outline of the diverticula is lost and barium may be seen escaping from them into an irregular abscess cavity The colon in the neighbour hood of the diverticulitis is usually contracted from spasm

PLATE 254
Diverticula of Sigmoid marked by arrow

PLATE 255
Polypoid Areas in Descending Colon indicated by arrows

Diverticulitis may produce in its advanced stage defects in the wall of the colon similar to a carcinoma and carcinoma of the colon may coexist or be grafted on to diverticulitis When this occurs the rest of the clinical picture must be considered The patient should be treated with washouts and given a suitable diet for diverticulitis and the radiographic examination repeated in about ten days In some cases the picture will if the diverticulitis settles down be then typical of diverticulosis

The chief clinical differences between diverticulitis and carcinoma of the colon are shown in the following table

	Diverticulitis	*Cancer of colon*
Patient	Acutely ill	Often not very ill
Temperature	Raised	Not raised
Abdomen	Tender colon	Not tender
Blood count	Leucocytosis	Normal or leucopenia
Passage of blood and mucus	None or rare	Marked

PLATE 256
Acute Intestinal Obstruction of Small Gut Note the dilatation and laddering of small gut.

Polypi (Plate 255) Polyposis of the colon is seen as round honeycomb areas in the lumen of the gut, retaining opaque media on their surface after the colon has been almost emptied It is often necessary to distend the colon with gas in order to show this unless the polyposis is so extensive that it almost obstructs the lumen of the bowel

ACUTE INTESTINAL OBSTRUCTION
(Plate 256)

The radiographic diagnosis of acute intestinal obstruction depends on the recognition that the gut is distended by an abnormal quantity of gas It is not necessary to give a barium meal The recognition of such conditions is difficult in the large gut, which is frequently seen distended in patients not suffering from intestinal obstruction In the small gut, on the other hand, intestinal obstruction may be recognised easily The gut is seen to contain much gas, which in itself is abnormal and the lumen appears enlarged, with the loss of the normal outline of the valvulae conniventes which can be recognised in undistended small gut The gut shows the typical 'laddering" appearance which is diagnostic of intestinal obstruction

The approximate position of the obstruction can often be diagnosed by tracing the gas distension downwards, when it will come to an abrupt end at the sight of the lesion If gas distension of the small gut can be traced through the ileo caecal valve into the caecum, the obstruction is in the large gut

This method is not suitable for the diagnosis of chronic obstruction, as gas distension does not occur to any extent, and a barium meal, if time permits, gives more information as to the position of the lesion

INTUSSUSCEPTION
(Plate 257)

Intussusceptions are found most often in young children, but occur sometimes (12 per cent) in adults, usually in conjunction with a pathological condition such as polypoid growth or Meckel s diverticulum

The condition can be demonstrated easily by a barium enema The emulsion flows easily to the area of the intussusception where the gut appears to end in an "egg-cup" formation. The intussusceptum is seen bulging into the barium-filled gut like a ball The barium may flow round the intussusceptum to a variable degree, enclosing it like a sheath

The importance of a radiographic examination of this condition is that the appearance is diagnostic and for this reason is of great importance in children who may first be seen when the abdomen is soft, the rigidity having disappeared The investigation is of particular use in the diagnosis of chronic intussusception in adults, which can often otherwise only be diagnosed by laparotomy or on post mortem examination

Extreme care must be used in giving the enema to children , the case should be screened throughout the examination, as the intussusception may be reduced spontaneously by the pressure of the enema While this may be safe in some cases in which the intussusception is easily reducible, it may end in disaster if the bowel is gangrenous and excessive pressure is applied by the enema

PLATE 157
Intussusception at the Distal Side of Hepatic Flexure demonstrated by barium enema indicated by arrows.

CHAPTER VI

THE GALL-BLADDER, KIDNEYS AND URINARY TRACT

THE GALL-BLADDER

The normal gall-bladder is not of sufficient opacity to X-rays to be differentiated from the surrounding organs When the gall-bladder outline has to be defined, this is done by means of cholecystography

All gallstones are not opaque to X-rays, but opaque gallstones can be seen on direct radiography of the gall-bladder region They have a smooth, ring-like outline, with usually a non-opaque centre

Care must be taken to distinguish them from calcification in the right costal cartilages and from an irregular transverse process of the first or second lumbar vertebrae

CHOLECYSTOGRAPHY

By cholecystography it is possible to define the outline of the gall-bladder and see whether suspected shadows in the upper right hypochondrium lie within or outside the gall-bladder Gallstones, which are non opaque, show themselves as "negative" shadows in the 'tetra'-filled gall-bladder

The technique of administration of 'tetra.' In order to obtain satisfactory filling of the gall-bladder with 'tetra,' it is important that the following instructions should be carried out carefully

The patient should be given a good laxative three days before the examination On the day before the examination no laxative should be given At the last meal, at 8 p m on this day, the patient should only have boiled fish, with the complete exclusion of all forms of fat As soon as this meal is finished, the patient should take, by the mouth, the 'tetra' (sodium phenoltetraiodo-phthalein) 4 grm., well dissolved in water acidified by sodium bicarbonate The patient should be given, half an hour later

℞ Tinct. opii } aā 5ni,
" belladonna }

as in some cases the 'tetra' produces vomiting and diarrhoea with failure to fill the gall-bladder

The first radiograph is then taken 14 hours after giving the 'tetra,' i e at 10 a m the next day No food or water must be given after the last meal has been taken

After the patient has been radiographed, he is given a meal of fried eggs to cause the gall-bladder to contract and concentrate

Subsequent pictures are then taken at 16 and 18 hours Failure to fill the gall bladder is no indication of a diseased gall-bladder In some cases, the 'tetra' examination may have to be repeated a second time when the gall-bladder has failed to fill the first time

THE NORMAL GALL-BLADDER OUTLINE

(Plates 258 and 261)

The shape of the 'tetra'-filled gall-bladder is elongated smooth and pear-shaped

It lies in the area between the 11th rib and the body of the third lumbar vertebra It may lie overlapping the shadow of the 12th rib or against the right side of the lumbar spine When it does this, a second radiograph must be taken with the patient slightly turned to throw the gall-bladder shadow free of the rib or the spine

After a meal containing fat, the gall-bladder empties rather more than half and its shadow shows increased density from concentration

GALLSTONES

Gallstones in some cases are opaque to X-rays and show themselves as ring-shaped shadows (Plate 260) Other gallstones can only be seen by 'tetra' examination as "negative" shadows in the gall-bladder (Plate 262)

PLATE 258
Normal Tetra Filled Gall bladder 14 hours after ingestion of the dye

PLATE 259
Lateral View of Spine Showing Gall bladder Relation The gall bladder contains 'tetra' and opaque stones indicated by arrow This view is sometimes used to distinguish between renal and gallstones on the right side Renal stones lie within the spinal shadow

Care must be taken not to interpret gas shadows in the gut overlying the gall bladder shadow as negative shadows Gas shadows can usually be traced lying beyond the wall of the gall bladder, or a second radiograph may be taken with the patient slightly turned so that the shadow of the gall-bladder is projected beyond the gut shadow In some cases an opaque shadow may lie in both the right upper kidney region and the gall-bladder region To determine its position, the patient should be radiographed in the right lateral position, when a renal stone is seen to lie at the side of the lumbar spine in the renal area, whereas a gallstone lies well in front of the spine (Plate 259)

PLATE 260
Multiple Gallstones

PLATE 261
Call bladder filled with Tetra and Contain ng Multiple Ring Shaped Stones

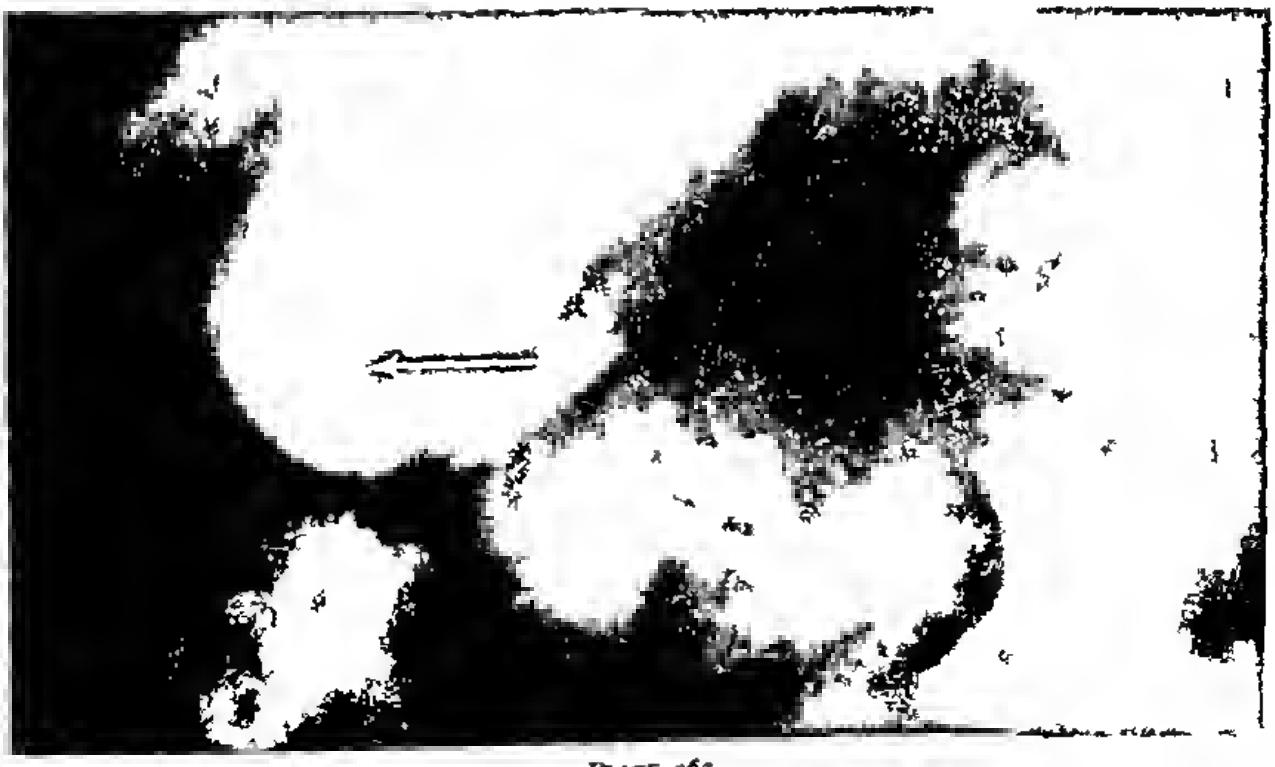


PLATE 262
Gall bladder f lled with Tetra with Non-opaque Gallstones ndicated as negative shadow by arrow

CHOLECYSTITIS

A large, poorly filled gall-bladder of subnormal opacity, which does not empty or become smaller on giving a fatty meal, is evidence of cholecystitis. Sometimes the gall-bladder shadow shows a "half-moon" shaped deformity at its base, indicating adhesion to the gut. An opaque meal should then be given to determine the relation of the gall-bladder to the duodenum and in some cases the duodenum will show a "half-moon" deformity (see page 217).

THE KIDNEY AND URINARY TRACT

The kidney outline can be seen on X-ray examination as a homogeneous density

PLATE 163
Renal Calculi. Both kidneys are occupied by multiple calculi.

PLATE 165
Gross Hydronephrosis, as shown by descending pyelography. Both pelvis and calyces are much dilated.

in the renal area normally equal to that of the psoas muscle, which limits it medially. The upper pole of the kidney lies at the level of the 11th dorsal vertebra, and the lower pole at the level of the 2nd lumbar vertebra.

The normal kidney measurements are 12 cm. long and 6 cm. wide, but unless gross variations are present in the sizes of the kidney shadow, no pathological condition can be diagnosed because of radiographic distortion

The ureters and bladder cannot be visualised with any degree of certainty without opaque media.

DIAGNOSIS OF RENAL CALCULUS IN THE KIDNEY AREA
(Plate 263)

An opaque shadow lying in the kidney area in an antero-posterior radiograph can only be diagnosed as a calculus if —

(1) A lateral view of the kidney shows the shadow lying in the kidney area. This differentiates between gallstones and calcified glands which both lie much anterior to the kidney shadow and often cannot be seen in the lateral radiograph

(2) By stereoscopic antero-posterior views the opaque shadows if a renal calculus can definitely be seen to he within the kidney substance

(3) By pyelography (q v)

PLATE 264

Descending Pyelography showing excretion at 15 minutes.

(1) Pelvis of kidneys
(2) Calyces with sharp outline on the left.
(3) Some blunting of the calyces on the right demonstrating dilatation The ureters do not strictly keep to the line of the outer ends of the transverse processes

DESCENDING PYELOGRAPHY

The method of administration Perabrodil or Uroselectan is injected intravenously according to the manufacturer s directions The patient should have no fluid for 36 hours previous to the examination otherwise the pyelogram shadow may be of insufficient density

X ray pictures should be taken at 5 10 and 15 minute intervals after the injection

The appearance of the radiograph (Plate 264) The outline of the calyces pelves

and often ureters can be seen in the 5-minute picture, becoming more dense at 10 and 15 minutes

Diagnosis of calculus. An opaque shadow which is suspected as a calculus in the renal tract can be eliminated if seen to lie outside the shadow of the calyces, pelves and ureters as defined by Perabrodil As an opaque shadow may be "blotted out" by Uroselectan, its position should be verified by a "control" picture taken before the injection is given

Appearance of hydronephrosis (Plate 265) Only the grosser degrees of hydronephrosis can be seen by this method The intensity of the shadow of the dilated calyces and pelves is reduced Often the deformed and blunted calyces can alone be seen in the kidney area, the pelvis remaining invisible If a gross hydronephrosis exists on one side, no shadow from the Uroselectan may be seen for an hour It is then necessary to take a radiograph in two hours when the hydronephrosis will be seen

Tumours of the pelvis of the kidney cannot be detected with any degree of certainty by this method, as colonic gas or an enlarged spleen may produce an apparent defect in the calyces or pelvis of the kidney (Plate 270)

ASCENDING PYELOGRAPHY

The method. Ureteric catheters having been introduced under local anaesthesia, stereoscopic pictures are taken of the renal tract to show the relation of any opaque

PLATE 266.

Ascending Pyelography (1) Ureteric catheter (2) Pelvis of kidney (3) Calyces There is no blunting of the ends of the calyces.

PLATE 267

Hydronephrosis shown by ascending pyelography (1) Right hydronephrotic kidney (2) Right kidney shows a defect in the upper calyx (tuberculous) (3) Calcified deposit (tuberculous) in substance of kidney

shadows to the catheters in the ureters Opaque shadows seen stereoscopically lying in contact with the catheters are definitely calculi

The pyelogram The calyces and pelvis of each kidney in turn are injected with sod iodide (13½ per cent) or bromide (20 per cent) The normal pelvis holds 7 c c of solution In the conscious patient when the pelvis is filled pain is felt in the loin on that side any further injection of fluid may produce pyelovenous backflow

When more than 10 c c. can be put into the pelvis of the kidney without the patient feeling pain (this should never be done on the unconscious patient) it indicates —

(1) that there is a hydronephrosis

(2) that the catheters have not been put sufficiently high up on the ureters and the solution may be running back into the bladder

The normal pyelogram (Plate 266) may show wide variations from the accepted normal and for this reason both kidneys should always be injected The normal calyces have a sharp clear-cut outline leading to a funnel shaped pelvis

Hydronephrosis (Plate 269) shows blunting of the calyces and dilatation of the pelvis

Causes of hydronephrosis —

(*a*) Congenital usually bilateral

(*b*) A stone in the pelvis of the kidney or ureter

(*c*) An aberrant artery causing kinking of the ureter (Plate 268)

(*d*) Gross ptosis of the kidney with the ureter kinked over the normal artery

PLATE 268
Hydronephrosis from Kinking of Ureter shown by ascending pyelography Arrow indicates kink.

PLATE 269
Hydronephrosis and Dilated Ureter shown by Ascending Pyelography

PLATE 270
Tumour of Kidney shown by descending pyelography Note the pelvis and calyces of the left kidney are deformed and spidery It should be confirmed by ascending pyelography unless the diagnosis is certain

PLATE 271
Tumour of Kidney shown by ascending pyelography The space between calyces and pelvis is defective from pressure of tumour
(1) Pelvis. (2) Calyces

Tumours of the kidney (Plate 271) Tumours of the kidney show filling defects of the pelvis, which may be considerably reduced in size, with narrowing of the stems of the calyces The latter are said to have a spidery appearance

The polycystic kidney (Plate 272) shows very gross enlargement of the kidney and of the pelvis, with irregular enlargement of the calyces

Both kidneys often show the same degree of enlargement

Tuberculosis of the kidney. The tuberculous kidney often shows numerous opaque areas of soft outline, which are less opaque than calculi

The pyelograms (Plates 267 and 273) usually show a certain degree of hydronephrosis with irregular areas of destruction of the kidney substance beyond the calyces which are filled with the contrast media

PLATE 272
Polycystic Kidney shown by ascending pyelography
The kidney extends from the twelfth rib above into the pelvis below

The investigation is of importance in estimating the degree of destruction of the kidney Bacteriological investigation of the urine should not be neglected if the radiograph fails to show a tubercular kidney

The "horse-shoe" kidney. The kidney shadows appear more vertical than in the normal The pyelograms vary much in outline In the most extreme cases the ureter on one side is seen to cross over to the other side In the less marked conditions (Plate 274) the pelves show a slight degree of hydronephrosis and the calyces of one or both kidneys appear to look backwards rather than outwards, as in the normal The ureters show some degree of dilatation

PLATE 273
Tuberculosis of Kidney as shown by ascending pyelography

A Shows the early stage
(1) Calcified opacity in kidney
(2) Irregularity of trumpet of calyx
The rest of the calyces and pelvis are within the normal limits

B Shows an advanced stage
The kidney containing large irregular tubercular cavities (3) communicating with the pelvis.

PLATE 274
Horse shoe Kidney

PLATE 275
Pyelovenous Backflow Note the white line running in irregular manner in the kidney substance

Pyelovenous backflow (Plate 275) If the pressure and filling of the pelvis is excessive the calyces may be ruptured and the opaque media may be seen to flow into the venous system of the kidney substance outside the contours of the pelvis and calyces This does not appear to produce any gross damage to the kidney or any symptoms in the patient

PLATE 276
Double Ureter Shown by ascending pyelography

THE URETER

The ureter is non-opaque to X rays

In ascending pyelography the opaque bougie shows the ureters to cross the transverse processes of the lumbar spine and the lower part of the sacroiliac joints Then pass outwards and turning sharply inwards two finger breadths internal to the ischial spine, they reach the bladder

In descending pyelography the line of the ureters uncontrolled by the catheters is very variable from picture to picture Seen on the screen they show undulatory motion on contraction of the pelvis of the kidney They may appear well outside the

line of the transverse processes and on either side of the sacroiliac joints in successive pictures

Calculi in the ureters are demonstrated by visualising the ureter with Uroselectan or by stereoscopy with opaque bougies in the ureters, with which calculi will be seen in contact

An example of double ureter is seen in Plate 276 as shown by ascending pyelography

THE URINARY BLADDER

The normal bladder is non-opaque to X-rays, a large opaque shadow lying within the bladder area is usually a calculus Its position may be verified by stereoscopy Diagnosis of small shadows in the bladder area can only be made by filling the bladder with 1 per cent potassium iodide solution and noting whether the shadow is within

PLATE 277
Bladder filled with Iodide Solution Note the gas defect from pressure of gut on the right hand side

PLATE 278
Bladder Half filled Note its scaphoid appearance

or outside the bladder by means of stereoscopic pairs or antero-posterior and lateral views

Opaque shadows outside the bladder area may be —

(1) Calculi in the ureters
(2) Small and round (usually multiple)—phleboliths
(3) Irregular shadows in women—calcified uterofibromata.
(4) Faecal shadows from incomplete preparation

The normal bladder wall. The appearance of the bladder filled and half-filled with potassium iodide is seen in Plates 277 and 278

Tumours of the bladder wall. The bladder when filled with opaque media shows irregular defects which, in the control picture, may show areas of calcification The bladder wall instead of appearing smooth is irregular and the outline of the tumour may be seen

Diverticula of the bladder (Plate 280) The outline of the bladder filled with opaque material shows definite diverticula arising from its surface in any direction (least commonly in front) It may be necessary to take radiographs in more than one

PLATE 2 9
Prostatic Calculi Note that they lie below the bladder and beh nd the symphysis pub s

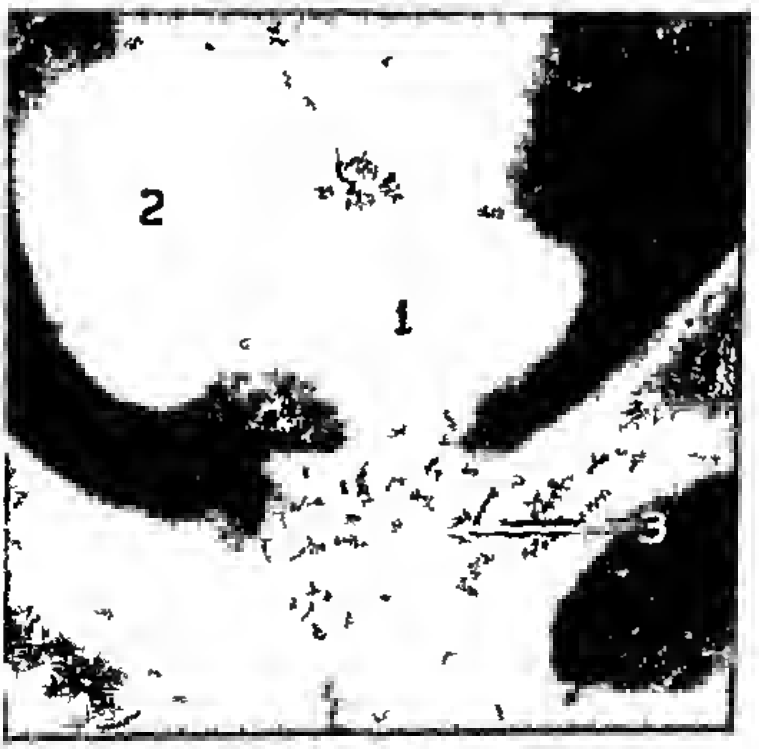


PLATE 80
The Bladder showing a Diverticulum and Prostatic Calculi The bladder (1) filled with iodide solution. (2) With a large diverticulum of bladder on the right side (3) Prostatic calculi, showing the relation of the prostatic calculi to the bladder and pelvis.

plane even steroscopically to demonstrate their presence They lie in such close proximity to the bladder itself that they are often obliterated by its shadow and may escape detection They sometimes contain opaque calculi

Prostatic calculi (Plate 279) Prostatic calculi are small opaque and usually multiple shadows which lie below the base of the bladder behind the symphysis pubis

CHAPTER VII

THE FEMALE GENERATIVE SYSTEM AND THE FOETUS

THE FEMALE GENERATIVE SYSTEM

Certain abnormal conditions of the female generative system can be diagnosed by a radiograph without resort to filling the uterus with contrast media

Numerous calcified areas of irregular outline lying in the true pelvis are produced as a rule by calcified fibroids which have undergone degenerative changes They are often without significance

A large ovarian cyst can usually be seen as an opaque rounded mass, rising out of the pelvis It is homogeneously opaque with its opacity rather more than that of a kidney shadow The importance of this radiograph is to diagnose it from a pregnancy with which, in women approaching the menopause, it can be confused It is important that the patient should first empty her bladder before the examination as a distended bladder shadow can be mistaken for an ovarian cyst

The filling of the cavity of the uterus with opaque media—lipiodol or Uroselectan is usually used—can easily be carried out if the patient has previously been given scopolamine and morphia It is however, a procedure for which a special injection syringe must be used and asepsis must be strictly carried out

The cannula of the syringe is introduced into the cervical canal and the flow of the contrast media is visualised on the fluorescent screen The best type of syringe has a screw action, so that only 1 c c of contrast media is injected at a time

Antero posterior and lateral films are always used to show the exact position of the uterus The normal uterine cavity is triangular in shape and the patent tube can be seen to either side of it

The opaque media is seen to flow into the fallopian tubes after it has filled the uterine cavity The normal tubes are seen as thin tube like opacities that become wider at the ampulla In blockage of the tube it is impossible to fill it Dilatation and irregularity in the lumen of the tubes can be easily recognised so that it is possible to recognise chronic salpingitis and tubal pregnancies

The position of the retroflexed and anteflexed uterus can be determined with great exactitude

In the infantile uterus, the uterine cavity is diminished and the length of the tubes is decreased

The cavity of a *bifid and double uterus* can be determined (Plate 281)

Fibroids of the uterus, if interstitial, produce distortion and lengthening of the uterine cavity Subserous fibroids, when large, cause displacement of the uterus away from them, while submucous fibroids cause smooth rounded defects in the uterine cavity All the deformities described often co-exist together

In carcinoma of the body of the uterus, the uterine cavity shows gross irregular filling defects

In cysts of the broad ligament, the uterine cavity is displaced to the opposite side and may be partly rotated If the fallopian tube on the side of the lesion is seen, it will be displaced upwards

In the case of ovarian cysts the cavity of the uterus remains normal and is displaced away from the lesion, the tube on that side being usually indeterminate

PLACENTA PRAEVIA

In normal pregnancy when the foetal head enters the pelvis it rests on the bladder In placenta praevia the placenta separates the head from the bladder The outline of the bladder is seen by distending it with a 2 per cent potassium iodide solution Stereoscopic antero-posterior and lateral radiographs are then taken, when the position of the head in relation to the bladder can be determined If the placenta lies over the base of the bladder it separates the foetal skull from the bladder by at least half an inch This method of examination fails if the head will not enter the pelvis In

PLATE 281
Double Uterus (1) Right uterine cavity (2) Left uterine cavity (3) Tube of left uterus

PLATE 282
Dead Foetus Note the overlapping of skull indicated by arrow

cases of marginal placenta praevia the head may appear to rest on the bladder A positive finding is of diagnostic value, but some degree of placenta praevia can exist with negative findings

THE RADIOGRAPHIC DIAGNOSIS OF PREGNANCY

The radiographic diagnosis of pregnancy can first be made in the 7th week but this method is replaced for early diagnosis by the Aschheim-Zondek biological test, which is conclusive as early as the fourth week

It must be remembered that if the foetus moves much as it does occasionally during the radiographic exposure it is possible that the foetus will not be seen on the film

It has been reported that in making a stereoscopic exposure for pregnancy one film has shown the foetus whereas in the second film no foetal parts can be seen

THE FOETUS IN UTERO

The importance of radiography of the foetus is to determine whether it will pass through the pelvis Many methods have been described for arriving at the measurements of the pelvic brim and outlet and some for measuring the size of the foetal head *in utero* All the formulae used in these methods at the present time, are empiric By most authorities they are admitted to be faulty, as they do not allow for the variations in the size or elasticity of the maternal parts nor can they allow for moulding of the foetal head a somewhat unknown quantity

Probably the most satisfactory method is that when there is any suspicion in the mind of the obstetrician of disproportion between the foetus and the pelvis a stereoscopic pair of radiographs should be taken of the pelvis including the head of the foetus On stereoscopy it will be possible in almost every case, to see whether or not the head will pass through the pelvis A second pair of stereoscopic radiographs, showing a lateral view of the pelvis will give further assistance

This method, though fairly simple, has given very good results, whereas complicated measurements have in many cases failed

Some guide to the age of the foetus may be obtained from the following table —

Weeks intl	*Centre seen on radiograph*
7	Facial bones limb girdles and clavicle
8	Inferior and superior maxillae 5th 6th and 7th ribs
9	All cervical and 1st dorsal vertebrae iliac wings radius and ulna, femoral diaphysis, tibia and fibula
10 13	Occipital and the other skull bones
21 25	Os calcis of the foot
24-28	Astragalus of the foot
25 28	Milk teeth
35	Distal femoral epiphysis
37	1st coccygeal segment
39	Proximal tibial epiphysis
40	First permanent molars, os magnum and capitate of hand

No centre of ossification is seen before the 7th week

DEATH OF THE FOETUS

There are two signs diagnostic of foetal death which are of importance —

(1) Gross disproportion between the size of the foetus and the known period of gestation

(2) Overlap of the bones of the foetal skull (Plate 282) This is usually most marked in the parietal region The head becomes somewhat triangular Care must be taken not to diagnose as foetal death the moulding of the skull, which occurs once the head begins to enter the pelvis

MALPOSITION AND MALPRESENTATION

The position of the foetus can be seen in the uterus with the greatest ease by means of a good radiograph

It is possible to distinguish —

(1) Vertex presentation
(2) Breech presentation with legs flexed
(3) Breech presentation with legs extended
(4) Transverse lie
(5) Multiple pregnancy
(6) Anencephaly

It is possible to distinguish between R O A , R O P , L O A and L O P by noting the position of the occiput If the mother was radiographed lying on her back, the detail of the front or back part of the skull (depending upon which is closest to the maternal spine) will show the same fine bone structure as the spine, whereas, in the part of the skull which is farther from the spine, there will be loss of detail and enlargement of the bone from radiographic distortion This will indicate whether the case is an O A or an O P Whether is it an R O or L O depends on being able to see to which side of the spine the occiput lies

CHAPTER VIII

TUMOURS OF THE SPINAL CORD AND VENTRICULOGRAPHY

TUMOURS OF THE SPINAL CORD

Tumours of the spinal cord which cause narrowing or obliteration of the dural canal can be detected by the injection of lipiodol at the cisternal end of the spine and radiographing the spine to see whether any of the oil is held up before it arrives at the lowest limit of the spinal canal with the patient sitting upright In the normal the opaque oil can be seen, on screening to trickle down the canal at a regular rate, depending on its amount If it is persistently held up at any level it is an indication of a narrowing of the spinal canal which may be caused by tumours of the cord or adhesions between the cord and the dura Plate 283 shows a tumour of the spinal cord producing a partial block

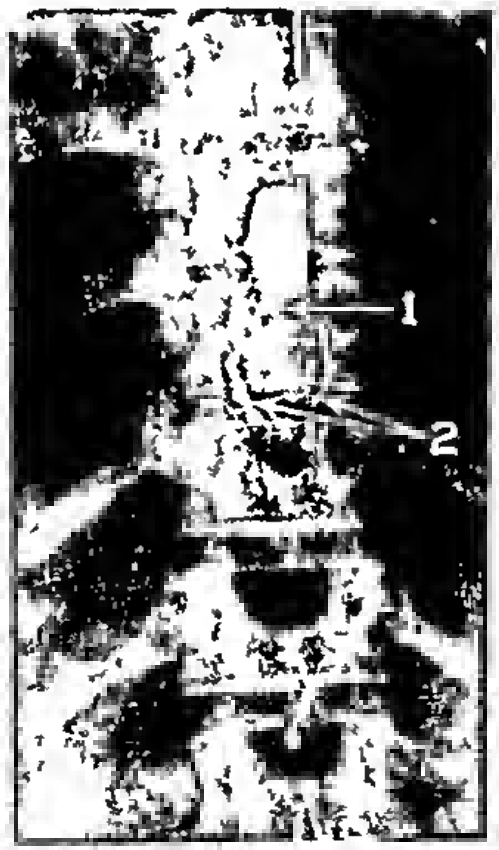


PLATE 83
Lipiodol Block in Spinal Canal produced by spinal cord tumour Lipiodol was introduced by cisternal puncture (1) Upper level of tumour (2) Some of the lipiodol has outlined the nerve roots

Antero-posterior view the face is upwards the air fills chiefly the anterior horns and bodies of the lateral ventricles

Posterior anterior view the face is down the air fills the bodies and the posterior part of the lateral ventricular system

Lateral view of ventricles The lateral ventricles are superimposed

PLATE 284

Ventriculography showing air displacement of cerebro-spinal fluid

(1) Body of lateral ventricles
(2) Descending horn of ventricles
(3) Third ventricle
(4) Aqueduct.
(5) Fourth ventricle

VENTRICULOGRAPHY

In ventriculography the cerebrospinal fluid in the ventricles is replaced by air This may be done by direct puncture of the ventricles through a trephine hole in the occiput and air replacement with a cannula or by draining off the cerebrospinal fluid by lumbar puncture and replacing with an equal quantity of air

Both these procedures should be carried out only by a surgeon and neurologist who have already been able to localise the position of the tumour and wish by means of ventriculography to verify the correctness of the localisation and demonstrate the extent of the lesion

Plate 284 shows the normal appearance of a ventriculography they should always be stereoscopic

The appearances by the different lesions of the brain are very numerous It is only possible to indicate a few of them here

A neoplasm in a lobe is recognised by the distortion which it produces in the normal outline of the ventricular system The ventricular system is often displaced away from the lesion This is seen in antero posterior and postero-anterior views The lateral ventricle on the opposite side to the lesion is often dilated but this is not a constant feature The lateral ventricle of the affected side may show the tumour bulging into it, or it may be completely obliterated

In general, a frontal lobe neoplasm affects the anterior horn in a temporal lobe tumour the descending horn as well as the body of the lateral ventricle is affected in a parietal lobe tumour the body of the lateral ventricle is distorted An occipital lobe tumour produces obliteration of the posterior and inferior parts of the lateral ventricle

When a neoplasm blocks a ventricle dilatation of the ventricles above it occur so that when ventricular dilatation exists it is possible to visualise the exact site of the lesion Plates 285 and 286 show dilatation of the ventricles from a tumour in the floor of the fourth ventricle Thorotrast has been injected and some of it has been absorbed by the endothelium lining the ventricles

PLATE 285

Hydrocephalus with thorotrast to show the degree of dilatation of the ventricles

PLATE 286

The same patient (285) three weeks later The thorotrast has been taken up by the ependyma which are now visible indicated by arrow

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